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THE DISTRIBUTION OF WEALTH.

By CHARLES S. ASHLEY.

ON a railroad-train one afternoon my conversation with a fellow-traveler, a successful merchant, turned on the vast fortunes which have been accumulated and transmitted during the present generation. "Where is this thing going to end?" said he. "Cornelius Vanderbilt left his son William about $50,000,000; eight years later William dies, and leaves $300,000,000. In the lifetime of his sons this ought to increase to $600,000,000;* and in the lifetime of *their* sons who can tell how much the Vanderbilt fortune will amount to? Legislation ought to put a stop to this business." He spoke very earnestly, his face assuming a tense, stern expression, as if he were confronting some personal enemy. Other persons in the car overheard and testified their interest in the subject by joining us, some of whom showed equal or greater vehemence in what was called the cause of labor; and the general sympathy seemed to be with the remarks I have quoted.

These persons, if I mistake not, may be said to represent a very general sentiment existing in this country—a sentiment almost completely pervading the laboring masses† and certain other special classes, such as the clergy and the women, and prevailing less extensively among our professional and merchant classes and our scholars. Newspapers advocating progressively severe income-taxes, the compulsory division of property at the death of the owner in ways insuring diffusion, the assumption of state control of telegraph lines, and the regulation of other corporations in such a manner as to insure a mini-

* These figures, uttered in actual conversation, are of course inaccurate.

† "The Toilers throw Theory and Sophistry to the Dogs, and take the Settlement of the Question into their own Hands." (Heading in "Toledo News" (labor paper), March 13, 1886.)

mum of profits, are too common to admit of mention. In high-class periodicals, too, like "The Century," we find plentiful manifestations of the same spirit. Sometimes, as in the article "Danger ahead," published in a late number of that magazine, the fear of violent revolution shows itself in the feverish manner of the argument, and may fairly be counted as the chief source of the opinions expressed; but, again, as in the recent papers of Washington Gladden, we find a calm discussion of socialism and conclusions favorable to it arrived at with no obvious bias. And in the pages of the most orthodox political economists we observe a kindred tendency. In Mill's "Political Economy" there is no exhaustive examination of the unequal distribution of wealth; but the tone of the whole work is, I think, expressive of regret that inequalities should be so great as they are. While considering inheritance he commends laws enforcing the division of accumulated wealth at death.* Elsewhere he denies that the proportioning of remuneration to work done is really just, except so far as the amount of work is a matter of choice; it is only "highly expedient."† This shows his feeling toward the existing system, and nearly all political economists exhibit a like feeling. And even in Mr. Fiske's "American Political Ideas," despite the magnificent pæan on our "manifest destiny," which is in effect a eulogy of our comparatively free economic system, we read with sympathetic regret of the progress of a typical Massachusetts village from a state of comparatively equal prosperity and intelligence to that of a manufacturing town, where the distance between the highest and lowest becomes in nearly all ways so great. Our affections incline toward this primitive homogeneity; our ideas have been largely molded by it and by the great struggle against slavery, with which we naturally, though erroneously, associate definite class divisions, to which we are obviously tending. Our feeling for the past, or rather our adaptation to it, joins with apprehension of the future to make us fear any further departure from homogeneity, and we are impelled along rather by the action of blind economic forces than by any one's wish. A perception of our economic tendencies voices itself roughly in the very inaccurate saying that "the rich are getting richer and the poor poorer," which is the burden of the works of Henry George and most of the socialistic writers; and the united action of society is invoked to remedy the unfair operation of economic laws.

Such being the ideas more or less vaguely prevalent, it may be interesting to examine—1. What has made possible the acquirement of the great fortunes of the present generation? 2. Will the favoring circumstances continue? 3. How should we regard the holding of millions by a single man and its inheritance by his family—perchance by a single son who could never have gained such wealth for himself?

* Mill's "Political Economy," vol. i, p. 289, American edition.

† Ibid., vol. i, p. 272. I can not reconcile this doctrine with the utilitarian philosophy.

Notwithstanding the interesting nature of these questions, they are seldom discussed, and Mr. Sidgwick is almost alone in a systematic examination of the third topic. Keeping in mind that no age has seen such vast accumulations of private wealth as the present, we take up the questions in order:

I. At first sight it is not clear why some few men apparently not much distinguished from the rest should gain such disproportionate rewards in wealth and power. Nearly all our great millionaires began as poor men, and in a few years they are possessed of incomes up among the millions. Many find this plainly unjust, and a condemnation of our entire economic system. Even though the laborer has also gained both in money-wages and in their purchasing power, as well as in decreased hours of labor, this is not sufficient; his share in the increase is unfair.* The capitalist gets an increasing share of the produce, and grinds the faces of the poor.

It might dampen the ardor of these reformers to reflect on the well-known fact that the average remuneration of capital in this country is not more than five per cent, as we may see in the fact that money can be borrowed on unquestioned security for much less. Here, however, we have to account for the extraordinary cases. There is nothing particularly difficult about it. As in armies we find man set over man and grade over grade, despite apparent equality, so in an age of commercial militancy, of universal competition and rapid transition, we find that a similar inequality is created.

For though industrialism is in many ways to be sharply contrasted to militancy, they agree in this—that in each there is a struggle for existence. And when by improvement in the means of competition this struggle becomes more constant and severe, and division of labor arises through the necessity of each to rely on his special power, there arises the same need of management and direction, and the same high reward is necessarily paid for it. Thus, the democratic civilization of our early history, whose ideal was that every citizen should own at least "forty acres and a mule," has given way to the modern militant industrial system. The application of steam to transportation led to universal competition, in which the strong waxed stronger and the weak became still weaker, at least relatively, or else sought pastures new. Man was set against man, town against town, and State against State; for States are competitors for the hire and business of the great world as men are competitors for the service of employers or in commerce for the service of their communities.† The men and towns and coun-

* Mr. Gladden, in "The Century" for March, 1886, p. 739. This mistake, which Mr. Gladden apparently makes his own, plainly springs from overlooking the fact that the share of labor in the produce is not simply the wages of employés directly in view, but the wages of all those, however distant, who contribute to it. *The capitalist's expenses are the remuneration of labor.*

† Socialistic writers regard this state of things with horror. It is curious to note,

tries best prepared for the new conditions have taken the lead and reaped the reward. The nations best qualified by habits of labor and enterprise for this vast competition were England and the United States. Among cities New York and Chicago have outstripped Norfolk and New Orleans. Among individuals certain industrial princes have been evolved, and these are our millionaires. On the face of the matter it is not apparent why Turkey or Spain has not as much claim on the increased wealth of the world, so large a proportion of which has been gained by the United States, as an ordinary citizen has on the profits which Mr. Gould derives from his telegraph system. If there were forty or fifty such countries situated near each other and capable of combining, very likely they would resolve that we had more than we ought to have, and compel us to disgorge our ill-gotten gains.

It is now apparent that the position to be here taken is that in the normal and usual case wealth is gained by doing a corresponding share of the world's work; and it may further be said that the amount of individual gain is no adequate measure of the public gain. A vague idea prevails that the great millionaires have gained their wealth through some mysterious and illegitimate trickery.* As very few are aware of the beneficial operation of speculation, which is really an insurance to the producer against undue fluctuation in the price of the product, operations in Wall Street lend some support to this idea. Then, too, the ordinary formula for profits given in books on political economy (profit = wages of superintendence + interest + recompense for risk) hardly aids us in understanding American fortune-getting as a normal process. This formula really means that profits have a tendency to fall or rise to the level stated. With actual profit, particularly when realized in a new commercial age, it has very little to do. The fact is that profit is based on the *value* of the service done the public, in the public estimation. For particular cases a more accurate formula is, profit equals the total money value of the service rendered, less expenses and the public profit therein. In small business enterprises the flow of capital into very profitable investments is very rapid, at least in all except new communities. But it has not been so with large enterprises. The immobility and mismanagement of capital have been so great that a high premium has been put upon unusual foresight and sagacity during the advent of the age of railways. The history of the Western Union Telegraph Company, and of the fortune of the first Cornelius Vanderbilt, furnish excellent illustrations: we choose the latter.

however, the complacency with which they regard displays of brute force, either under the form of war or riot, or in the shape of a law backed by the superior force of society.

* The Rev. Mr. Abbott shows this feeling in his article in "The Century" for November, 1885, where he assumes that no man's service can be worth more than a million a year to the public.

When "Commodore" Vanderbilt began the railroad business in 1863, the railroads of the country had not emerged from the character in which they were originally conceived—they were improved turnpikes chiefly for local business. Rivalry with the canal for the transportation of heavy articles was hardly thought of. The shipment of freight for any great distance was a matter of no small expense, delay, and risk. In short, the present railroad system of the country, by which Dakota exchanges her wheat, produced at an expense of about thirty cents a bushel (instead of about sixty-five in New York), for Eastern manufactures, produced under equally advantageous circumstances, was yet embryonic. In the transformation of local lines into highly organized and efficient systems, which give the public much better service at much lest cost, two men were especially conspicuous—Cornelius Vanderbilt and Thomas A. Scott. More discerning than the rest, these men saw the need and the possibility of improvement, and organized the New York Central and Pennsylvania systems. The ultimate result is well known. Rates from Chicago to New York in 1868 were from five to ten time as high as at present,* and the service given was in every way inferior to that now furnished. But this in itself is a comparatively trifling matter. Without the cheap transportation thus furnished, the world would be without the major part of the rich product now annually pouring from Texas, Kansas, Dakota, and the rest of our inland territory. The earnings of every man in the United States and England have thus been incraased. Even the Eastern farmer has been benefited, paradoxical as it may seem; for Mr. Atkinson has shown that the value of the product of Massachusetts farms has been greatly increased by the fact that the farmer no longer has to raise his own cereals, but can devote his entire farm to perishable fruits, etc., which bring high prices.† Large as were the gains to the great corporations thus organized, and to Mr. Vanderbilt and his compeers, they were almost infinitesimal when compared with the gains of the public.

This is the outline of the history of the Vanderbilt fortune. The substance of it is, that his organizing and constructive ability enabled him to offer a great boon to the public, and he succeeded in securing a share of the result of his labor—a much smaller proportionate share than the laborer ordinarily receives. His reward was based on the value of his service and not on his expenses. Similarly with other branches of business. The manufacturer and merchant most prompt in meeting the new economic conditions outstripped competitors, and the public were benefited, notwithstanding the discomfiture of the less efficient.

Differences in practical ability to appreciate the new world should prepare us for corresponding differences in the theoretical under-

* Hadley's "Railroad Transportation," p. 93.

† See his admirable pamphlet, "The Railroads of the United States."

standing of it. And, indeed, the political economists, reckoning in all who write on economic topics, are so far apart that the authority of their science has greatly declined in the past twenty years, owing to the general doubt as to what the science really stands for. In the early part of this century our politicians were probably our best economists. Now the difference between the leading politicians who make our laws and the men who write is appalling or grotesque, as we may choose to look at it. Looking over the whole ground, a physicist would say that the inventions of the present century were forces falling on units already unlike, and they necessarily led to increased divergence in wealth and intelligence. Dissimilarity once initiated bred dissimilarity. Those successful under the new *régime* were able to combine their capital and undertake large and profitable enterprises. Here, again, appeared differences. Probably a majority of those who so invested have either lost money or have at least failed to make much, as we may be sure from the fact that the average return on capital actually invested in railroads in this country is less than four per cent; and, of course, the return to the original undertakers was even less. Others, however, like Mr. Vanderbilt, reaped a rich reward; and thus came increased divergence.

Enough has been said, I think, to make it clear—and indeed it is obvious at first thought—that the golden opportunities seized by our business chiefs have been offered principally because the past age has been one of enormously rapid transition. Very few men were adapted to the new circumstances, and those few necessarily reaped a large profit. Such violent and disorderly transitions are very uncomfortable; and it is to this fact, if the foregoing views are correct, that we must ascribe the manifestations of irritation even among those obviously benefited—manifestations which are to be found in our literature, our universal hurry, and our entire conduct of life.*

II. The second question—Will the circumstances favoring the sudden aggregation of wealth continue?—is thus in large measure answered by the first. It now takes the form, How long will the period of active transition continue? This question naturally divides itself into two others, which may be separately discussed:

1. What is the prospect of new inventions which will have a power of disturbance similar to that already shown by steam and electricity? This is, of course, very hard to say, but we are not altogether without light. No great alteration in methods of business is possible except through improvement in the means of transportation, and through the removal of artificial obstructions to transportation, such as tariffs and other interferences of the government with the

* Our feverish haste struck Mr. Spencer as our leading national trait. And in "The Nation" of August 30, 1883, is a thoughtful and striking editorial, in which it is remarked that discontent, so far from being peculiar to the working class, pervades all classes.

natural course of trade. When the circulatory system of the body politic is complete, the evolution of the body is complete. And, if the discovery of some Keely motor or of some practicable method of navigating the air is made, we shall probably enter on another period of transition as violent as the last. But there is very little expectation of anything of the kind. Unless a "negative gravity," like that in Mr. Stockton's clever story, is discovered, it is not easy to see how even the navigation of the air would effect much change in our system of transportation, for air-ships could hardly carry coal or heavy merchandise. The probability seems to be, therefore, that we have approximated our limit. Subsequent improvements will be matters of detail, such as the extension of existing lines or the perfecting of economical railroad operation. A system under which a piano can be shipped a thousand miles for less than the price charged by the drayman who takes it to the final destination, is hardly susceptible of revolutionary improvements. Producers at any one locality are already practical competitors with the rest in their line of business. No system of transportation, however perfect, can accomplish very much more.

2. When will the violence of the transition brought about by steam and electricity subside? When will the industrial population become adapted to the new environment? When will society cease to pay such high premiums on organizing ability? Clearly when the necessary organization is approximately complete. So long as wealth can be more advantageously employed in unaccustomed amounts or in unaccustomed ways, this premium will be paid and the present phenomena will continue, for owing to the inertia which possesses capital as well as everything else, the demand for it in the particular directions will be greater than the supply, and a rise of price will be the result. Now, it may be said with some confidence that the crisis is already past. In England the year 1845 may be taken as the highest point of the disturbance in departing from the old homogeneous system to the modern division-of-labor system; and in America, probably the year 1869, which witnessed the completion of the Union Pacific Railroad, is a corresponding period. The severity of the financial crises which overtook both countries near the years mentioned seems to indicate the substantial accuracy of this estimate. If this conjecture is valid, we are justified in saying that men are now running a more even race for business success. Differences between individuals in the common business qualities are, of course, quite great; but no one person and no hundred persons so far surpass all others as to cause such results as those seen in the past twenty years.

If, then, we may take the view that the great modern inventions have spent the greater part of their disturbing force, we may conclude that we are passing from a period where "multiplication of effects," or divergence, has been the rule, to one of segregation and equilibra-

tion; or, to express it in more common terms, from a time of disorderly and confused industrial action to one of harmonious orderly organization. The introduction of the new elements into the commercial world changed, as it were, the polarities of our industries. They are still adjusting themselves to the new basis, but the adjustment has now a much more regular and orderly manner than at first. Evidence of the steady progress toward harmonious organization is to be found in the decreasing violence of railroad traffic wars; in the greater caution of the speculating and investing publics; in the development of pools to regulate traffic and production in all industries; and in the slow but steady advance toward satisfactory relations between labor and capital.* All these are parts of a process which we may best call economic segregation, and, rightly conceived, they may give us at least a general idea of the course of our economic evolution.

To attempt particular description of the operation of a given force is hazardous, even in comparatively simple sciences. Much more so is it in sociology. Still, we are forced to look forward as well as backward, and must form some idea of the future operation of what we see working about us every day. In this place, several agencies tending to the diffusion of wealth, or rather its segregation into the hands of comparatively large bodies of men capable of handling it, may be noted. First, and most important, perhaps, come corporations. No one, so far as I am aware, has yet treated of them with any approach to adequacy. Objects of general dislike, they exist rather by their own inherent efficiency than because they are held in any proper estimation. We have, indeed, but to look around us and notice the gigantic increase in their number and power, and in the number interested in or employed by them to see their vast import. A dispassionate view of the subject will, in my opinion, convince a competent person that the general economic function of a corporation is to perform steadily, cheaply, and permanently, a service which an individual can only perform briefly, and with comparative inefficiency. Where corporations can not do this, they are unable to exist; and, in consequence of their permanence, they are able to give lasting employment, and, therefore, more than any other mode of industrial organization, they are apt to give the right man the right place; as we may see in the history of most of our prominent railroad men. And when this process of segregation is complete, corporations will undoubtedly be made up of those who actually perform their service. The immense saving

* Recent strikes and riots are apt to blind us to the progress really made in this respect. The question is hardly in order here; but it may be pointed out (1) that strikes are accompanied with less violence than formerly, as in 1877, for example; (2) that organized bodies like the Knights of Labor are more responsible to public opinion than unorganized labor; and (3) that great advances have been made in particular cases.

and the superior efficiency to be thus gained are apparent; and in the struggle of corporation against corporation, it is evident that this form of organization will be evolved as soon as the honesty and intelligence of the laboring classes will admit of it. Next, we may specify organizations very like the foregoing in principle, but which are commonly regarded with as much favor as corporations with the reverse. We refer to co-operative associations. In communities where there is little change from year to year, these may assume considerable importance. Then come labor organizations. When trades-unions were first prominently introduced, the general feeling was one of fright; and in this country there is still some uneasiness as to the working of our great labor organizations. Here they can only be noticed as a part of that segregation everywhere going on. General considerations thus lead us to a belief in their beneficent results, in spite of the many mistakes which they have committed, and will continue to commit. Next, we may recall that all unequal distribution tends to die out, unless, as has been so conspicuously the case in the last twenty years, the aggregation of property in single hands gives a great advantage in its management. Inheritance is a perpetual force for equal distribution. It may, indeed, be counteracted by stronger forces, either political, as in the feudal system, or commercial. But the management of combinations of property is now so usual and easy, as we may see in the case of the Vanderbilt property, that the divisive principle has full sway. Lastly, it needs no prophet to predict that the passion for immense wealth characterizing "great, intelligent, avaricious, sensual America," will decline. In its extreme form it is a passing characteristic of a transitional age; it is like the feverish and senseless desires of youth. Like the passion for power, which "the generality of mankind love so much more than liberty," it must decline when no longer necessary; and it will never again, probably, be so necessary as in the present generation. In so far as passion for power, or show, or wealth entails discomforts, it is bound to die out, unless there are compensating advantages; for they hamper their devotees in the race for survival.

How far we have reached in this great process is a much-mooted question. Numerous instructive facts are, however, before our very eyes. The fabulous amounts spent by the laboring classes for amusements, liquor, tobacco, and various things regarded as luxuries; the amount of money the labor organizations are able to handle; the vast increase in national wealth—out of all proportion to the increase in population—competing for the hire of labor; the great increase in savings-bank deposits and depositors; the proved increase in money-wages, and in the purchasing power of wages; the decrease, still going on under our very eyes, of the hours of labor; the reduced fluctuations in prices; the increased average length of life, recognized by insurance companies; the increased consumption of necessaries *per*

capita *—all these seem to point to the fact that great progress has already been made.

The general view here taken of our recent economic evolution may be stated in mechanical terms. Mr. Spencer's words are somewhat abstract and difficult to fully comprehend, as a great many eminent persons have found out; but they must here be quoted for the perfection with which they cover the case:

"In the second order" (of equilibrations), "comprehending the various kinds of vibration or oscillation as usually witnessed, the motion is used up in generating a tension which, having become equal to it, or momentarily equilibrated with it, thereupon produces a motion in the opposite direction, that is subsequently equilibrated in like manner, thus causing a visible rhythm, that is, however, soon lost in invisible rhythms." †

III. Having endeavored to view the phenomena of wealth-distribution from an evolutionary standpoint, let us now eliminate the element of time, and see if we may thus obtain additional light by altering our point of view. The question is, What is the most advantageous distribution of wealth at a given moment? In seeking a reply, the following considerations inevitably come before the mind:

1. "A more equal distribution of wealth tends *prima facie* to increase happiness"; ‡ since the amount of happiness given by wealth obviously increases, not directly as the wealth, but in a constantly decreasing ratio. But—

2. We have to allow for a decrease in the amount of wealth produced. This would result, first, from the increased idleness of large numbers engaged in productive employments. Probably there are persons that would deny that any such decrease would take place. A little observation of the advantage taken by the Indians of governmental interference with distribution in their favor would probably bring such persons a little nearer to the earth; especially if it were followed up by some study of the numerous ways in which most working-men get rid of their hard-won earnings. Another loss similar to the above would be through decreased saving. Increased idleness and increased non-productive expenditure, as for drink, amusements, etc., would lessen the total national capital. Still another loss would come through the lessened efficiency of capital in the management of enterprise—very much like the lessened efficiency of an army if each soldier were required to develop his views on the next movement of the campaign; for it must be assumed that interference with the ratios of distribution would tend to give the workmen power over the management of the capital. Here, again, there will very likely be

* See Mr. Giffin's admirable pamphlet, which has been much grumbled at by men who are eager to try their hands at remaking the world in a day, but whose figures and facts remain.

† "First Principles," p. 487.

‡ Sidgwick, p. 517, and after.

some denial, and a great many expressions of doubt; but it seems sufficient to say that, if the more democratic form of industry were at present practicable, it would not have failed so often as it has in picked cases. Lastly, not only would there be less wealth to distribute, but the number among whom it would be divided would, from known biological laws, be increased in a startling ratio; only afterward to diminish with the same excessive speed when the penalty for waste fell upon the world.*

It thus becomes plain that it is difficult, not to say impossible, to tell where a more equal distribution of wealth will be for the public advantage; and particularly *how* equal the distribution should be. It is a matter far too delicate for the wisest assembly that ever sat. Even if this were not the case, there should still be no interference with the natural ratios of distribution, and for this reason, which lies at the heart of all our remarks: *that the want of economic virtues in the mass is the exact measure of the advantage of the few.* The few can not surpass the many except as their superiority permits, and any limitation of the free action of the superior is therefore certain to result in public economic damage; and hence the best adaptation of the ratios of distribution is natural, and not artificial or legislative. The result of our special examination is a confirmation of our general examination.

We have still to deal with the question of inheritance. The acquisition of large properties in this way is in conflict with the first principle of a free industrial system, which in general requires each person to earn what he gets, excepting children and the infirm or aged. Here too, however, there are opposing considerations. In the first place, there is no way to prevent the transmission of property—if wills were made legally null, their office could be practically occupied in various ways. Even overlooking this obstacle, we are confronted with the damage resulting from the embargo on the natural activities and affections of men. The economic damage thus resulting would be inestimable. Again, the management of property acquires, by means of inheritance and bequest, a stability very necessary for the best results. And here, too, as in the former case, it is impossible to be sure that the spontaneous desires of men do not in the long run lead to the public advantage. Probably the sentiments governing this matter are as much the offspring of social discipline as the sentiments called moral. We find that customs of inheritance change from age to age and conform to the temper of the time. In an age like the present the first

* A certain increase of population has, as Mr. George says, the effect of increasing every man's share of the total production, through the increased division of labor allowed; but, obviously, that increase can outrun the capacity for profiting by it. If the entire population of China were landed in the United States at once, a great many—several hundred millions, probably—would starve before our industrial system could adapt itself to the vast increase of population.

object generally in the mind of a rich man, aside from the care of his family, is the welfare of the property bequeathed. In this respect the will of the late Mr. Vanderbilt was conspicuous. The measures taken to secure the united management of the great fortune left by him may be highly commended simply as a piece of public policy. It is not too much to say that, if, in consequence of a contrary policy, the New York Central or Vanderbilt system of roads had gone to pieces, the whole northern part of the United States would have suffered substantial injury.

A sentiment regarding the disposition of property at death, noticed by J. S. Mill as existing in America, still retains its hold; we mean the sentiment favoring the settlement of great sums on charities, churches, and especially on educational institutions. A California millionaire has recently set aside an immense fortune, said to amount to $20,000,000, for a university in that State. From an economic point of view there is absolutely no defense of such an action. It simply means the perpetual expenditure—the economic waste—of the whole annual yield of the property donated. Of course, the defense can be made that as property is for life, and not life for property, we should not regard wealth spent on things so necessary as education as misapplied. And if it be taken for granted that future ages will not know enough, or will not have the means to pay for the education needful for them, this is a good defense. But if, as we must here maintain, it be thought that the wants of a time are best met by the spontaneous agency of the time—as we see in the superiority of our popularly-sustained churches over state-supported establishments—then, from a social as well as from an economic standpoint, we must decide against the advisability of such great gifts. The possibility that our mania for education may lead to as much loss and inconvenience as the former mania which resulted in state religious establishments seems to be forgotten. Leaving all this aside, however, it should still be borne in mind that such a withdrawal of capital as that instanced is a distinct injury to trade and to the working classes; and further that any perpetuity is almost certain to become unresponsive to the needs of a new age, and is likely to become as useless as are, according to Professor Huxley, the great endowments which maintain fellowships at the English universities. Wherever the line between benevolent and reproductive expenditure should be drawn, it seems highly probable that the public sentiment in favor of public legacies is unduly strong, at least among those whose views find their way into print; and that the private sentiment which we see in daily operation is really much more beneficial to the country.

If the views taken in this article have any basis in truth, the opinions commonly held are to a large extent wrong in nearly every way connected with the present subject. Public opinion is, indeed, a vague and indefinite quantity. But we may fairly say that it opposes the

accumulation of large quantities of wealth in single hands; while such accumulation has not only been indispensable, as it still is, in developing our country, and an indispensable reward of enterprise, but, even leaving this out of account, is for the greatest good of the greatest number because it best preserves capital and employs labor most productively. We may say that public opinion favors interference with the natural ratios of distribution, as may be seen by usury laws, exemption laws, laws abridging freedom of contract, river and harbor bills, laws imposing heavy taxes on corporations, and so forth; while in general the natural ratios are the best for the public interest. Only the most immediate considerations are generally weighed; and unjust laws, like the Potter railroad law of Wisconsin, have to result in manifest public damage before they are repealed. It can hardly be doubted that before the late war, when the Jeffersonian maxims in regard to legislation still held sway, our political development was higher than it has been since; and the same may be said of our general ideas on public policy. But unceasing education in business methods of thinking are plainly forcing public opinion in the right direction, as was proved by the tone of the public press regarding the recent strike on the Missouri Pacific, and by the strong attacks lately made on the Blair education bill. Meanwhile there will be much of what might be called unnecessary blundering and suffering; but in reality this will be necessary to develop the needed habits and ideas.

METEORITES, METEORS, AND SHOOTING-STARS.*

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YOU are kindly giving to me an hour to-night in which I may speak to you. I do not have enough confidence in myself to justify me in speaking to such an audience as this upon one of those broad subjects that belong equally to all sections of the Association. The progress, the encouragements, and the difficulties in each field are best known to the workers in the field, and I should do you little good by trying to sum up and recount them. Let me rather err, then, if at all, by going to the opposite extreme.

Two years ago your distinguished president instructed and delighted us all by speaking of the pending problems of astronomy, what they are, and what hopes we have of solving them. To one subject in this one science, a subject so subordinate that he very properly gave it only brief notice, I ask your attention. I propose to state some propositions which we may believe to be probably true about the meteorites, the meteors, and the shooting-stars.

* Address of the retiring President of the American Association for the Advancement of Science, delivered at Buffalo, August 19, 1886.

In trying to interest you in this subject, so remote from the studies of most of you, I rely upon your sense of the unity of all science, and at the same time upon the strong hold which these weird bodies have ever had upon the imaginations of men. In ancient times temples were built over the meteorite images that fell down from Jupiter, and divine worship was paid them, and in these later days a meteorite stone that fell last year in India became the object of daily anointings and other ceremonial worship. In the fearful imagery of the Apocalypse the terrors are deepened by there falling "from heaven a great star burning as a torch," and by the stars of heaven falling "unto the earth as a fig-tree casteth her unripe figs when she is shaken of a great wind." The "great red dragon, having seven heads and ten horns, and upon his heads seven diadems" is presented in the form of a huge fire-ball. "His tail draweth the third part of the stars of heaven, and did cast them to the earth." Records of these feared visitors, under the name of flying dragons, are found all through the pages of the monkish chroniclers of the middle ages. The Chinese appointed officers to record the passage of meteors and comets, for they were thought to have somewhat to say to the weal or woe of rulers and people.

By gaining in these later days a sure place in science, these bodies have lost their terrors, but so much of our knowledge about them is fragmentary, and there is still so much that is mysterious, that men have loved to speculate about their origin, their functions, and their relations to other bodies in the solar system. It has been easy, and quite common, too, to make these bodies the cause of all kinds of things for which other causes could not be found.

They came from the moon; they came from the earth's volcanoes; they came from the sun; they came from Jupiter and the other planets; they came from the comets; they came from the nebulous mass from which the solar system has grown; they came from the fixed stars; they came from the depth of space. They supply the sun with his radiant energy; they give the moon her accelerated motion; they break in pieces heavenly bodies; they threw up the mountains on the moon; they made large gifts to our geologic strata; they cause the auroras; they give regular and irregular changes to our weather. A comparative geology has been built up from the relations of the earth's rocks to the meteorites; a large list of new animal forms has been named from their concretions; and the possible introduction of life to our planet has been credited to them. They are satellites of the earth; they travel in streams, and in groups, and in isolated orbits about the sun; they travel in groups and singly through stellar spaces; it is they that reflect the zodiacal light; they constitute the tails of comets; the solar corona is due to them; the long coronal rays are meteor-streams seen edgewise.

Nearly all of these ideas have been urged by men deservedly of

the highest repute for good personal work in adding to human knowledge. In presence of this host of speculations, it will not, I hope, be a useless waste of your time to inquire what we may reasonably believe to be probably true. And if I shall have no new hypotheses to give to you, I offer as my excuse that nearly all possible ones have been already put forth. This Association exists, it is true, for the advancement of science, but science may be advanced by rejecting bad hypotheses as well as by framing good ones. I begin with a few propositions about which there is now practical unanimity among men of science. Such propositions need only be stated. The numbers that are to be given express quantities that are open to revision and moderate changes:

1. The luminous meteor-tracks are in the upper part of the earth's atmosphere. Few, if any, appear at a height greater than one hundred miles, and few are seen below a height of thirty miles from the earth's surface, except in rare cases, when stones and irons fall to the ground. All these meteor-tracks are caused by bodies which come into the air from without.

2. The velocities of the meteors in the air are comparable with that of the earth in its orbit about the sun. It is not easy to determine the exact values of those velocities, yet they may be roughly stated as from fifty to two hundred and fifty times the velocity of sound in the air, or of a cannon-ball.

3. It is a necessary consequence of these velocities that the meteors move about the sun and not about the earth as the controlling body.

4. There are four comets relating to four periodic star-showers that have occurred on the dates of April 20th, August 10th, November 14th, and November 27th. The meteroids which have given us any one of these star-showers constitute a group, each individual of which moves in a path which is like that of the corresponding comet. The bodies are, however, now too far from one another to influence appreciably each other's motions.

5. The ordinary shooting-stars in their appearance and phenomena do not differ essentially from the individuals in star-showers.

6. The meteorites of different falls differ from one another in their chemical compositions, in their mineral forms, and in their tenacity. Yet through all these differences they have peculiar common properties which distinguish them entirely from all terrestrial rocks.

7. The most delicate researches have failed to detect any trace of organic life in meteorites.

These propositions have practically universal acceptance among scientific men. We go on to consider others which have been received with hesitation, or in some cases have been denied.

With a great degree of confidence we may believe that shooting-stars are solid bodies. As we see them they are discrete bodies, separated even in prolific star-showers by large distances one from another.

We see them penetrate the air many miles, that is, many hundred times their own diameters at the very least. They are sometimes seen to break in two. They are sometimes seen to glance in the air. There is good reason to believe that they glance before they become visible.

Now, these are not the phenomena which may be reasonably expected from a mass of gas. In the first place a spherical mass of matter at the earth's distance from the sun, under no constraint and having no expansive or cohesive power of its own, must exceed in density air at one sixth of a millimetre pressure (a density often obtained in the ordinary air-pump) or else the sun by his unequal attraction for its parts will scatter it. Can we conceive that a small mass of gas with no external constraint to resist its elastic force can maintain so great a density?

But suppose that such a mass does exist, and that its largest and smallest dimensions are not greatly unequal; and suppose further that it impinges upon the air with a planetary velocity; could we possibly have as the visible result a shooting-star? When a solid meteorite comes into the air with a like velocity, its surface is burned or melted away. Iron masses and many of the stones have had burned into them those wonderful pittings or cupules which are well imitated, as M. Daubrée has shown, by the erosion of the interior of steel cannon by the continuous use of powder under high pressure. They are imitated also by the action of dynamite upon masses of steel near which the dynamite explodes. Such tremendous resistance that mass of gas would have to meet. The first effect would be to flatten the mass, for it is elastic; the next to scatter it, for there is no cohesion. We ought to see a flash instead of a long burning streak of light. The mass that causes the shooting-star can hardly be conceived of except as a solid body.

Again, we may reasonably believe that the bodies that cause the shooting-stars, the large fire-balls, and the stone-producing meteor, all belong to one class. They differ in kind of material, in density, in size. But from the faintest shooting-star to the largest stone-meteor we pass by such small gradations that no clear dividing lines can separate them into classes. See wherein they are alike:

1. Each appears as a ball of fire traversing the apparent heavens just as a single solid but glowing or burning mass would do.

2. Each is seen in the same part of the atmosphere, and moves through its upper portion. The stones come to the ground, it is true, but the luminous portion of their paths generally ends high up in the air.

3. Each has a velocity which implies an orbit about the sun.

4. The members of each class have apparent motions which imply common relations to the horizon, to the ecliptic, and to the line of the earth's motion.

5. A cloudy train is sometimes left along the track, both of the stone-meteor and of the shooting-star.

6. They have like varieties of colors, though in the small meteors they are naturally less intense and are not so variously combined as in the large ones.

In short, if bodies that produce the various kinds of fire-balls had just the differences in size and material which we find in meteorites, all the difference in appearances would be explained, while, on the other hand, a part of the likenesses that characterize the flights points to something common in the astronomical relations of the bodies that produce them. This likeness of the several grades of luminous meteors has not been admitted by all scientific men. Especially was it not accepted by your late president, Professor J. Lawrence Smith, who by his studies added so much to our knowledge of the meteorites. The only objection, however, so far as I know, that has been urged against the relationship of the meteorites and the star-shower meteors, and the only objection which I have been able to conceive of that has apparent force, is the fact that no meteorites have been secured that are known to have come from the star-showers. This objection is plausible, and has been urged both by mineralogists and astronomers as a perfect reply to the argument for a common nature to all the meteors. But what is its real strength? There have been in the last one hundred years five or six star-showers of considerable intensity. The objection assumes that, if the bodies then seen were like other meteors, we should have reason to expect that among so many hundreds of millions of individual flights a large number of stones would have come to the ground and have been picked up.

Let us see how many such stones we ought to expect. A reasonable estimate of the total number of meteors in all of these five or six showers combined makes it about equal to the number of ordinary meteors which come into the air in six or eight months. Inasmuch as we can only guess at the numbers seen in some of the showers, let us suppose that the total number for all the star-showers was equal to one year's supply of ordinary meteors. Now, the average annual number of stone-meteors of known date from which we have secured specimens has during this hundred years been about two and a half.

Let us assume, then, that the luminous meteors are all of like origin and astronomical nature; and further assume that the proportion of large ones, and of those fitted to come entirely through the air without destruction, is the same among the star-shower meteors as among the other meteors. With these two assumptions, a hundred years of experience would then lead us to expect two or perhaps three stone-falls from which we secure specimens during all the half-dozen star-showers put together. To ask for more than two or three is to demand of star-shower meteors more than other meteors give us. The failure to get these two or three may have resulted from chance, or from some pecul-

iarity in the nature of the rocks of Biela's and Tempel's comets. It is very slender ground upon which to rest a denial of the common nature of objects that are so similar in appearance and behavior as the large and small meteors.

It may be assumed, then, as reasonable that the shooting-stars and the stone-meteors, together with all the intermediate forms of fire-balls, are like phenomena. What we know about the one may with due caution be used to teach facts about the other. From the mineral and physical nature of the different meteorites we may reason to the shooting-stars, and from facts established about the shooting-stars we may infer something about the origin and history of the meteorites. Thus it is reasonable to suppose that the shooting-stars are made up of such matter and such varieties of matter as are found in meteorites. On the other hand, since star-showers are surely related to comets, it is reasonable to look for some relation of the meteorites to the astronomical bodies and systems of which the comets form a part.

This common nature of the stone-meteor and the shooting-stars enables us to get some idea, indefinite but yet of great value, about the masses of the shooting-stars. Few meteoric stones weigh more than one hundred pounds. The most productive stone-falls have furnished only a few hundred pounds each, though the irons are larger. Allowing for fragments not found, and for portions scattered in the air, such meteors may be regarded as weighing a ton, or it may be several tons, on entering the air. The explosion of such a meteor is heard a hundred miles around, shaking the air and the houses over the whole region like an earthquake. The size and brilliancy of the flame of the ordinary shooting-star are so much less than those of the stone-meteor that it is reasonable to regard the ordinary meteoroid as weighing pounds, or even ounces, rather than tons.

Determinations of mass have been made by measuring the light and computing the energy needed to produce the light. These are to be regarded as lower limits of size, because a large part of the energy of the meteors is changed into heat and motion of the air. The smaller meteors visible to the naked eye may be thought of without serious error as being of the size of gravel-stones, allowing, however, not a little latitude to the meaning of the indefinite word gravel. These facts about the masses of shooting-stars have important consequences.

The meteors, in the first place, are not the fuel of the sun. We can measure and compute within certain limits of error the radiant energy emitted by the sun. The meteoroids large enough to give shooting-stars visible to the naked eye are scattered very irregularly through the space which the earth traverses, but in the mean each is distant two or three hundred miles from its near neighbors. If these meteoroids supply the sun's radiant energy, a simple computation shows that the average shooting-star ought to have a mass enormously greater than is obtained from the most prolific stone-fall. Moreover, if

these meteoroids are the source of the solar heat, their direct effect upon the earth's heat by their impact upon our atmosphere ought also to be very great; whereas the November star-showers, in some of which a month's supply of meteoroids was received in a few hours, do not appear to have been followed by noticeable increase of heat in the air.

Again, the meteoroids do not cause the acceleration of the moon's mean motion. In various ways the meteors do shorten the month as measured by the day. By falling on the earth and on the moon they increase the masses of both, and so make the moon move faster. They check the moon's motion, and so bringing it nearer to the earth shorten the month. They load the earth with matter which has no momentum of rotation, and so lengthen the day. The amount of matter that must fall upon the earth in order to produce in all these ways the observed acceleration of the moon's motion has been computed by Professor Oppolzer. But his result would require for each meteoroid an enormous mass, one far too great to be accepted as possible. Again, the supposed power of such small bodies, bodies so scattered as these are even in the densest streams, to break up the comets or other heavenly bodies, and also their power by intercepting the sun's rays to affect our weather, must in the absence of direct proof to the contrary be regarded as insignificant.

So, too, their effect in producing geologic changes by adding to the earth's strata, has without doubt been very much over-estimated. During a million of years, at the present rate of say fifteen millions of meteors per day, there comes into the air about one shooting-star or meteor for each square foot of the earth's surface. To assume a sufficient abundance of meteors in ages past to accomplish any of these purposes is, to say the least, to reason from hypothetical and not from known causes. The same may be said of the suggestion that the mountains of the moon are due to the impact of meteorites. Enormously large meteoroids in ages past must be arbitrarily assumed, and, in addition, a very peculiar plastic condition of the lunar substance in order that the impact of a meteoroid can make in the moon depressions ten, or fifty, or a hundred miles in diameter, surrounded by abrupt mountain-walls, two and three and four miles high, and yet the mountain-walls not sink down again.

The known visible meteors are not large enough nor numerous enough to do the various kinds of work which I have named. May we not assume that an enormous number of exceedingly small meteoroids are floating in space, are falling into the sun, are coming into our air, are swept up by the moon? May we not assume that some of these various forms of work, which can not be done by meteoroids large enough for us to see them as they enter the air, are done by this finer impalpable cosmic dust? Yes, we make such an assumption. There exist, no doubt, multitudes of these minute particles traveling

in space. But science asks not only for a true cause, but a sufficient cause. There must be enough of this matter to do the work assigned to it. At present we have no evidence that the total existing quantity of such fine material is very large. It is to be hoped that through the collection and examination of meteoric dust we must soon learn something about the amount which our earth receives. Until that shall be learned, we can reason only in general terms. So much matter coming into our atmosphere as these several hypotheses require would without doubt make its presence known to us in the appearance of our sunset skies, and in a far greater deposit of meteoric dust than has ever yet been proved.

A meteoroid origin has been assigned to the light of the solar corona. It is not unreasonable to suppose that the amount of the meteoroid matter should increase toward the sun, and the illumination of such matter would be much greater near the solar surface. But it is difficult to explain upon such an hypothesis the radical structure, the rifts, and the shape of the curved lines that are marked features of the corona. These seem to be inconsistent with any conceivable arrangement of meteoroids in the vicinity of the sun. If the meteoroids are arranged at random, there should be a uniform shading away of light as we go from the sun. If the meteoroids are in streams along cometary orbits, all lines bounding the light and shade in the coronal light should evidently be approximately projections of conic sections, of which the sun's center is the focus. There are curved lines in abundance in coronal light, but as figured by observers and in the photographs they seem to be entirely unlike any projections of conic sections. Only by a violent treatment of the observations can the curves be made to represent such projections. They look more as though they were due to forces at the sun's surface than at its center. If those complicated lines have any meteoroid origin (which seems very unlikely) they suggest rather the phenomena of comets' tails than meteoroid streams or sporadic meteors. The hypothesis that the long rays of light which sometimes have been seen to extend several degrees from the sun at the time of the solar eclipse are meteor-streams seen edgewise seems possibly true but not at all probable.

The observed life of the meteor is only a second, or at most a few seconds, except when a large one sends down stones to remain with us. What can we learn about its history and origin? Near the beginning of this century, when small meteors were looked on as some form of electricity, the meteorites were very generally regarded as having been thrown out from the lunar volcanoes. But as the conviction gained place that the meteorites moved not about the earth but about the sun, it was seen that the lunar volcanoes must have been very active to have sent out such an enormous number of stones as are needed in order that we should so frequently encounter them. When it was further considered that there is no proof that lunar volcanoes are now

active, and that when they were active they were more likely to have been open seas of lava, not well fitted to shoot out such masses, the idea of the lunar origin of the meteorites gradually lost ground. But the unity of meteorites with shooting-stars, if true, increases a hundred-fold the difficulty, and would require that the comets have the same origin with the meteorites. No one claims that the comets came from the moon.

That the meteorites came from the earth's volcanoes is still maintained by some men of science, particularly by the distinguished astronomer royal for Ireland. The difficulties of the hypothesis are, however, exceedingly great. In the first place, the meteorites are not like terrestrial rocks. Some minerals in them are like minerals in our rocks. Some irons are like the Greenland terrestrial irons. But no rock in the earth has been yet found that would be mistaken for a meteorite of any one of the two or three hundred known stone-falls. The meteorites resemble the deep terrestrial rocks in some particulars, it is true, but the two are also thoroughly unlike. The terrestrial volcanoes must also have been wonderfully active to have sent out such a multitude of meteorites as will explain the number of stone-falls which we know and which we have good reason to believe have occurred. The volcanoes must also have been wonderfully potent. The meteorites come to us with planetary velocities. In traversing the thin upper air they are burned and broken by the resisting medium. Long before they have gone through the tenth part of the atmosphere, the meteorites usually are arrested and fall to the ground. If these bodies are sent out from the earth's volcanoes, they left the upper air with the same velocity with which they now return to it. This the law of gravitation demands. What energy must have been given to the meteorite before it left the volcano to make it traverse the whole of our atmosphere and go away from the earth with a planetary velocity! Is it reasonable to believe that volcanoes were ever so potent, or that the meteorites would have survived such a journey?

No one claims that the meteors of the star-showers, nor that their accompanying comets, came from the earth's volcanoes. To ascribe a terrestrial origin to meteorites is, then, to deny the relationship of the shooting-star and the stone-meteor. Every reason for their likeness is an argument against the terrestrial origin of the stones.

To suppose that meteors came from any planets that have atmospheres involves difficulties not unlike to and equally serious with those of a terrestrial origin. The solar origin of meteorites has been seriously urged and deserves a serious answer. The first difficulty which this hypothesis meets is that solid bodies should come from the hot sun. Besides this, they must have passed without destruction through an atmosphere of immense thickness, and must have left the sun with an immense velocity. Then there is a geometric difficulty. The meteorite shot out from the sun would travel under the law of gravitation

nearly in a straight line out and back again into the sun. If in its course it enters the earth's atmosphere, its relative motion, that which we see, should be in a line parallel to the ecliptic, except as slightly modified by the earth's attraction. A large number of these meteors —that is most, if not all, well-observed fire-balls—have certainly not traveled in such paths. These did not come from the sun.

It has been a favorite hypothesis that the meteorites came from some planet broken in pieces by an internal catastrophe. There is much which mineralogists can say in favor of such a view. The studies of M. Stanislas Meunier and others into the structure of meteorites have brought out many facts which make their hypothesis plausible. It requires, however, that the stone-meteor be not regarded as of the same nature as the star-shower meteor, for no one now seriously claims that the comets are fragments of a broken planet. The hypothesis of the existence of such a planet is itself arbitrary ; and it is not easy to understand how any mass that has become collected by the action of gravity and of other known forces should by internal forces be broken in pieces and these pieces rent asunder. The disruption of such a planet by internal forces, after it has by cooling lost largely its original energy, would be specially difficult to explain.

We can not then look to the moon nor to the earth, nor to the sun, nor to any of the large planets, nor to a broken planet, as the first home of the meteoroids, without seeing serious if not insuperable objections. But since some of the meteoroids were in time past certainly connected with comets, and since we can draw no line separating shooting-stars from stone-meteors, it is most natural to assume that all of them are of a cometary origin. Are there any insuperable objections that have been urged against the hypothesis that all of the meteoroids are of like nature with the comets, that they are in fact fragments of comets, or it may be in some cases minute comets themselves?

If such objections exist, they ought evidently to come mainly from the mineralogists, and from what they find in the internal structure of the meteorites. Astronomy has not as yet furnished any objections. It seems strange that comets break in pieces, but astronomers admit it, for it is an observed fact. It is strange that groups of these small bodies should run before and follow after comets along their paths; but astronomers admit it is a fact in the case of at least four comets. Astronomically there would seem to be no more difficulty in giving such origin to the sporadic meteor, and to the large fire-ball, and to the stone-meteor, than there is in giving it to the meteor of the star-shower. If, then, the cometic origin of meteorites is inadmissible, the objections must come mainly from the nature and structure of the meteoric stones and irons. Can the comet in its life and history furnish the varied conditions and forces necessary to the manufacture or growth of these peculiar structures? It is not necessary, in order to answer this question, to solve the thousand puzzling problems that

can be raised about the origin and behavior of comets. Comets exist in our system, and have their own peculiar development, whatever be our theories about them. It will be enough for my present purpose to assume as probably true the usual hypothesis that they were first condensed from nebulous matter; that that matter may have been either the outer portions of the original solar nebula, or matter entirely independent of our system and scattered through space.

In either case the comet is generally supposed, and probably must be supposed, to have become aggregated far away from the sun. This aggregation was not into one large body to be afterward broken up by disruption or by solar action. The varieties of location of the cometic orbits seem inexplicable upon any such hypothesis. Separate centers of condensation are to be supposed, but they are not *a priori* unreasonable. This is the rule rather than the exception everywhere in Nature. Assume, then, such a separate original condensation of the comet in the cold of space, and that the comet had a very small mass compared with the mass of the planets. Add to this the comet's subsequent known history as we are seeing it in the heavens. Have we therein known forces and changes and conditions of such intensity and variety as the internal structure of the meteorites calls for?

What that structure is, and to some extent what conditions must have existed at the time and place of its first formation, and during its subsequent transformations, mineralogists rather than astronomers must tell us. For a long time it was accepted without hesitation that these bodies required great heat for their first consolidation. Their resemblance to the earth's volcanic rocks was insisted on by mineralogists. Professor J. Lawrence Smith, in 1855, asserted, without reserve, that "they have all been subject to a more or less prolonged igneous action corresponding to that of terrestrial volcanoes." Director Haidinger, in 1861, said, "With our present knowledge of natural laws, these characteristically crystalline formations could not possibly have come into existence except under the action of high temperature combined with powerful pressure."

The likeness of these stones to the deeper igneous rocks of the earth, as shown by the experiments of M. Daubrée, strengthened this conviction. Mr. Sorby, in 1877, said: "It appears to me that the conditions under which meteorites were formed must have been such that the temperature was high enough to fuse stony masses into glass; the particles could exist independently one of the other in an incandescent atmosphere subject to violent mechanical disturbances; that the force of gravitation was great enough to collect these fine particles together into solid masses, and that these were in such a situation that they could be metamorphosed, further broken up into fragments, and again collected together."

Now, if meteorites could come into being only in a heated place, then the body in which they were formed ought, it would seem, to

have been a large one. But the comets, on the contrary, appear to have become aggregated in small masses. The idea that heat was essential to the production of these minerals was at first a natural one. All other known rock formations are the result of processes that involved water, or fire, or metamorphism. All agree that the meteorites could not have been formed in the presence of water or free oxygen. What conclusion was more reasonable than that heat was present in the form of volcanic or of metamorphic action?

The more recent investigations of the meteorites and kindred stones, especially the discussions of the Greenland native irons and the rocks in which they were imbedded, are leading mineralogists, if I am not mistaken, to modify their views. Great heat at the first consolidation of the meteoric matter is not considered so essential. In a late paper M. Daubrée says: "It is extremely remarkable that, in spite of their great tendency to a perfectly distinct crystallization, the silicate combinations which make up the meteorites are there only in the condition of very small crystals all jumbled together as if they had not passed through fusion. If we may look for something analogous about us, we should say that instead of calling to mind the long needles of ice which liquid water forms as it freezes, the fine-grained texture of meteorites resembles rather that of hoar-frost and that of snow, which is due, as is known, to the immediate passage of the atmospheric vapor of water into the solid state." So Dr. Reusch, from the examination of the Scandinavian meteorites, concludes that "there is no need to assume volcanic and other processes taking place upon a large heavenly body formerly existing, but which has since gone to pieces."

The meteorites resemble the lavas and slags on the earth. These lavas and slags are formed in the absence of water, and with a limited supply of oxygen, and heat is present in the process. But is heat necessary for the making of the meteorites? Some crystallizations do take place in the cold; some are direct changes from gaseous to solid forms. We can not in the laboratory reproduce all the conditions of crystallization in the cold of space. We can not easily determine whether the mere absence of oxygen will not account fully for the slag-like character of the meteorite minerals. Wherever crystallization can take place at all, if there are present silicon and magnesium, and iron and nickel, with a limited supply of oxygen, there silicates ought to be expected in abundance, and the iron and nickel in their metallic form. Except for the heat, the process should be analogous to that of the reduction of iron in the Bessemer cupola, where the limited supply of oxygen combines with the carbon and leaves the iron free. The smallness of the comets should not, then, be an objection to considering the meteoric stones and irons as pieces of comets. There is no necessity for assuming that they were parts of a large mass in order to provide an intensely heated birthplace.

But, although great heat was not needed at the first formation, there

are many facts about these stones which imply that violent forces have in some way acted during the meteorite's history. The brecciated appearance of many specimens; the fact that the fragments in a breccia are themselves a finer breccia; the fractures, infiltrations, and apparent faultings seen in microscopic sections, and by the naked eye—these all imply the action of force. M. Daubrée supposes that the union of oxygen and silicon furnishes sufficient heat for making these materials. If this is possible, those transformations may have taken place in their first home. Dr. Reusch argues that the repeated heating and cooling of the comet as it comes down to the sun and goes back again into the cold, is enough to account for all the peculiarities of structure of the meteorites. These two modes of action do not, however, exclude each other.

Suppose, then, a mass containing silicon, magnesium, iron, nickel, a limited supply of oxygen, and small quantities of other elements, all in their primordial or nebulous state (whatever that may be), segregated somewhere in the cold of space. As the materials consolidate or crystallize, the oxygen is appropriated by the silicon and magnesium, and the iron and nickel are deposited in metallic form. Possibly the heat developed may, before it is radiated into space, modify and transform the substance. The final result is a rocky mass (or possibly several adjacent masses) which, sooner or later, is no doubt cooled down throughout to the temperature of space. This mass in its travels comes near to the sun; powerful action is there exerted upon it. It is heated. How intense is that heat upon a cold rock unprotected apparently by its thin atmosphere it is not possible to say. We know that the sun's action is strong enough to develop and drive off into space that immense train, the comet's tail, that sometimes spans our heavens. It is broken in pieces. We have seen the portions go away from the sun, to come back probably as separate comets. Solid fragments are scattered from it, to travel in their own independent orbits.

What is the condition of the burned and crackled surface of a cometic mass or fragment as it goes out from the sun again into the cold? What changes and recrystallizations may not that surface undergo before it comes back again to pass anew through the fiery ordeal? We have here forces that we know are acting. They are intense, and act under varied conditions. The stones subject to those forces can have a history full of all the scenes and actions required for growth of such strange bodies as these that come down to us. Some of our meteors, those of the star-showers, certainly had that history. What good reason is there for saying that all of them may not have had the like birthplace and life?

Before I close, let me add one lesson that has been taught us by recent star-showers. The pieces which come into our air in any recurring star-shower belong to a group whose shape is only partly known. It is thin, for we traverse it in a short time. It is not a uniform ring,

for it is not annual, except possibly in the case of the August sprinkle. How the sun's unequal attraction for the part of a group acts as a dispersive force to draw it out into a stream, those most beautiful and most fruitful discussions of Signor Schiaparelli have shown. The groups that we meet are certainly in the shape of thin streams.

It has been assumed that the cometic fragments go continuously away from the parent mass so as to form in due time a ring-like stream of varying density, but stretched along the entire elliptic orbit of the comet. The epochs of the Leonid star-showers in November, which have been coming at intervals of thirty-three years since the year 902, have led us to believe that this departure of the fragments from Tempel's comet (1866, 1) and the formation of the ring were very slow processes. The meteors which we met near 1866 were therefore thought to have left the comet many thousands of years ago. The extension of the group was presumed to go on until at some time in the future, perhaps tens of thousands of years hence, the earth was to meet the stream every year.

Whatever may be the case with Tempel's comet and its meteors, this slow development is not found to be true for the fragments of Biela's comet. It is quite certain that the meteors of the splendid displays of 1872 and 1885 left the immediate vicinity of that comet later than 1840, although at the time of those showers they had become separated two hundred millions of miles from the computed place of the comet. The process, then, has been an exceedingly rapid one, requiring, if continued at the same rate, only a small part of a millennium for the completion of an entire ring, if a ring is to be the finished form of the group.

It may be thought reasonable, in view of this fact about Biela's comet, established by the star-showers of 1872 and 1885, to revise our conception of the process of disintegration of Tempel's comet also. The more brilliant star-showers from this comet have always occurred very near the end of the thirty-three-year period. Instead of there being a slow progress which is ultimately to produce a ring along the orbit of the comet, it certainly seems more reasonable to suppose that the compact lines of meteors which we met in 1866, 1867, and 1868, left the comet at a recent date. A thousand years ago this shower occurred in the midle of October. By the precession of the equinoxes and the action of the planets the shower has moved to the middle of November. One half of this motion is due to the precession of the equinoxes, the other half to the perturbing action of the planets. Did the planets act upon the comet before the meteoroids left it; or upon the meteoroid stream? Until one has reduced the forces to numerical values, he may not give to this question a positive answer. But I strongly suspect that computations of the forces will show that the perturbations of Jupiter and Saturn upon the group of meteoroids hundreds of millions of miles in length—perturbations strong enough to change the node of

the orbit fifteen degrees along the ecliptic—would not leave the group such a compact train as we found it in 1866. If this result is at all possible, it is because the total action is scattered over so many centuries. But it seems more probable that the fragments are parting more rapidly from the comet than we have assumed, and that long before the complete ring is formed the groups become so scattered that we do not recognize them, or else are turned away so as not to cross the earth's orbit.

Comets by their strange behavior and wondrous trains have given to timid and superstitious men more apprehensions than have any other heavenly bodies. They have been the occasion of an immense amount of vague and wild and worthless speculation by men who knew a very little science. They have furnished a hundred as yet unanswered problems which have puzzled the wisest. A world without water, with a strange and variable envelope which takes the place of an atmosphere, a world that travels repeatedly out into the cold and back to the sun, and slowly goes to pieces in the repeated process, has conditions so strange to our experience, and so impossible to reproduce by experiment, that our physics can not as yet explain it. Yet we may confidently look forward to the answer of many of these problems in the future. Of those strange bodies, the comets, we shall have far greater means of study than of any other bodies in the heavens. The comets alone give us specimens to handle and analyze. Comets may be studied, like the planets, by the use of the telescope, the polariscope, and the spectroscope. The utmost refinements of physical astronomy may be applied to both. But the cometary worlds will be also compelled, through those meteorite fragments with their included gases and peculiar minerals, to give up some additional secrets of their own life and of the physics of space to the blow-pipe, the microscope, the test-tube, and the crucible.

SOME OUTLINES FROM THE HISTORY OF EDUCATION.

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II.

WE may define history as the narration of events in their causal relations. Nowhere does this definition find more instructive application than in the evolution of education. We see here, and with unmistakable plainness, the effect of distinctive contributions from the sides of our common nature. The stages in the history of education are *natural* growths; each movement in the unfolding was a necessity. Our present paper will consider many facts which, by themselves, would appear so unnatural, so out of relation to modern

thought and feeling, that we could but gaze upon them in wonder. Not one of these manifestations, however, but is rooted in the inborn constitution of our fellows. To recognize this is to sympathize with the past—that is, to understand it, wherein also, and wherein alone, we realize the present. The history of education from the early Christian centuries throughout the middle-age period is the expression of a one-sided development starting from a misunderstood Christianity. The new religion was contra-natural, contra-earthly; its training was for heaven. Though some may claim that this teaching did not lie fairly in the authoritative records of the Church, there was much in these records to favor it, and much more still in the situation of the first Christians. Persecution would force attention from things temporal to things eternal. The present would be but a trial, a testing. This misinterpretation was laid upon the early Christians even as it seems to be laid upon many unfortunate souls to-day. Those for whom life is a ceaseless curse need such power as may well be said to come from on high to place the blame where it belongs, on broken law and wasted opportunity. The gospel of a heaven on earth, of a heaven in and by law, of a heaven in and by the present right life, is not even now fully come, though we give thanks for its presence here and there.

My former paper called attention to the following points: the early relations of Christian education with heathen education, the gradual extension of Christianity and the shaping of all instruction for a religious life, Arabian culture, the character of middle-age education as unnatural, contra-earthly. We shall now look directly at this middle-age training. Where did the teachers of the middle ages teach? In the cloister schools, the cathedral schools, and the parochial schools. These parochial or common schools never amounted to much, because the masses of the people had little interest in knowledge. Still, at a comparatively early time the popes established the parochial schools by the side of the parish church. Charlemagne ordered that the children should be instructed in reading, singing, reckoning, some grammar and writing; and a council held at Mainz, before the middle of the ninth century, required that the children should be sent either to the cloister schools or to those of the parish, that they might learn the Creed and the Lord's Prayer in their own language. The cloister schools are classed as those of the Benedictines, Dominicans, and Franciscans. The first Benedictine monastery was founded at Monte Casino, in the kingdom of Naples, about 529, by St. Benedict himself. This order increased so wonderfully and became so powerful that it may be said to have been the chief means for the spread of learning throughout the West from the sixth to the twelfth century. At first the regulations of St. Benedict were for those only who had set themselves apart to the service of the Church. But, with the increase of the reputation of the order, it

became necessary to provide instruction for those scholars who were not devoting themselves to the monkish life. In keeping with this demand, the cloister schools were established: there were also so-called nunneries of this order, the first at Bischofsheim, in France, being widely celebrated. These cloister schools for girls did the work of elementary schools, and concerned themselves especially with household duties. The supreme importance of this Benedictine order ceased in the twelfth century. Then the Dominicans and Franciscans took up the work, and, though they did not accomplish so much as the other orders, their results were marked in providing better school-books. They taught mostly the Lord's Prayer, church melodies, and Latin.

A word as to the origin of the cathedral schools. While the Benedictine order was becoming powerful, the parochial schools suffered greatly from the ignorance and incapacity of the parish priests. This disturbed Chrodegang (Bishop of Metz, 742) so greatly that he took the priests who were connected with his own cathedral and bound them together in a cloister-like seclusion for the instruction of the youth according to the Benedictine rules. Their life was ordered by strictest regulations, their duties were accurately written down for them, and their chief instruction consisted of the Holy Scriptures and song. The life in these cathedral schools was a modified monkish life—the good work they did for education is justly said to be this, that they made it freer, bringing it out of the cloisters and more into general view.

What did the young people study in the middle-age schools? First and most essential was religion; after that, the following: grammar, rhetoric, and dialectic; music, arithmetic, geometry, and astronomy. The first three of these were called the *trivium* (as suggested, probably, because in Rome it was customary to give elementary instruction in some public place where three or more roads came together). The four other studies were called the *quadrivium*. In North Africa the trivium and quadrivium came together for the first time and formed what was known as the seven liberal arts; seven, being a sacred number, gave great value to this circle of study. Any one making the least pretension to education must pass through the trivium; the quadrivium was for those who had finished the first course and desired further training.

We inquire as to the meaning of these seven studies of the middle ages:

Grammar.—This consisted of instruction in the Latin language. First, the scholar learned to pronounce, then he mastered the quantity of the syllables, the forms of the declensions and conjugations; then he took up some productions of the easier Latin writers; and, finally, went on to the more difficult prose authors and poets. After this, he learned accent, the number of feet in the verse, analogy, etymology, and foreign words. Then the Latin author was explained critically;

every verse was taken to pieces and looked at grammatically, meterically, and historically. (They had rules for the position of the mouth in pronunciation.) Greek was, after some time, introduced into the Western schools and taught in the same general manner as the Latin. Hebrew was seldom an object of study. The modern languages were not taught.

DIALECTIC.—This represented philosophy in general. In the lower schools it was a mere collection of phrases. The boy learned the categories, the moods and figures of the syllogism and practiced definitions and disputations. There was a partial translation of Plato's "Timæus," which prevailed to the thirteenth century. In the higher schools, especially from the tenth to the twelfth century, religion was taught in connection with philosophy, and this latter study was in every way made to defend the faith.

RHETORIC.—This was taught, at first, according to Quintilian and Cicero; later the text-books of Capella and Bede took their place; in the tenth century Quintilian became again the leader. The rules of rhetoric were applied to sermon-writing, and the first treatise on this subject was composed about the year 1300.

MUSIC.—This study received special attention. Ambrose of Milan originated the church songs, and Charlemagne summoned teachers of song from Rome, and laid great stress upon musical training. Instruction in this department was based upon the text-books of Boëthius, and the notes were marked by the letters of the alphabet until Benedict of Pomposa and Guido of Arezzo (1030) introduced the system of lines. The marking of the notes according to their continuance and length was devised in the fourteenth century by Johns of Myris, while before this the higher and lower notes were expressed by ascending and lowering lines.

ARITHMETIC.—This was next to music in importance as an object of study. To express numbers the hands and feet were used. The left hand upon the breast signified 10,000 and both hands 100,000. In business and housekeeping accounts a reckoning-board was used. This was a table upon which upright parallel lines were cut, that represented values of units, tens, hundreds, etc. These lines were filled with stones to express numbers: thus, for 4,576 we should have on the first line at the right, six stones, then seven, and so on.

GEOMETRY.—This was taught in the higher and lower schools after selections from Euclid. Lines, figures, and solids were defined, and chief examples of them given. There was generally associated with this study a kind of geography, and it is said that the cloister of St. Gallen had a map as early as the seventh century.

ASTRONOMY.—This study, which had been pursued long before among the Greeks, and which was a principal concern with the Arabians, received no attention in the Western Church until Charlemagne had some correspondence with Rabanus respecting it. The schools

used an Englishman's book, called the Book of the Spheres. As is well known, astronomy was very closely bound up with astrology, of which there was a professorship in the University of Bologna. In the lower schools all instruction in astronomy was confined to the reckoning of the Easter feasts and the Church calendar.

We have thus outlined the principal objects of pursuit during the middle ages. History had no place in the course of study. Jurisprudence, as it came from Rome, did receive, in some places, special attention from the priestly orders. At York it took the place of dialectic and was studied for the cultivation of the judgment. Physics and chemistry were pursued secretly, if at all, and the former degenerated into magic, the latter into alchemy.

Possibly this review of the middle-age studies may have obscured the leading idea with which we started, and by which the entire period is characterized—that is, the idea of religion.

The following words from a leader in middle-age education will show the grasp of the Church upon all the training of the time:

"Grammar discloses the art of explaining the old poets and writers; at the same time it gives ability to read and write without mistake. By grammar alone we understand the figures and unaccustomed modes of speech of the Sacred Scriptures and seize the true meaning of the divine words.

"Prosody, also, one should not neglect, because in the Psalms there are many kinds of verses; for this reason the fluent reading of heathen poets and frequent practice in poetry are not to be disregarded. But the old poets must first be very carefully purified, that nothing remain in them which has reference to love and love ceremonies, or to the heathen deities. Rhetoric, which gives the different classes and chief parts of speech, together with the accompanying rules, is important for such young persons only as have nothing more serious to attend to, and it must be learned only out of the holy fathers. Dialectic, on the other hand, is the queen of all the arts and sciences. In her dwells reason. Philosophy alone can furnish knowledge and wisdom; she alone declares what and whence we are, she alone teaches us our destination, through her alone we learn to know the good and the evil. How necessary she is for the priestly man, that he may contend with and overcome the unbeliever! Arithmetic is important because of the secrets which are contained in numbers, and Scripture requires arithmetic to be learned, in that the Holy Word speaks of numbers and measures. Geometry is necessary because, in Scripture, at the building of Noah's Ark and Solomon's Temple, circles of all kinds appear.

"Music and astronomy are necessary for divine service, which, without music, could not be conducted worthily and impressively, and without astronomy could not be held on set and appointed days."

We have now, in our outline, reached that period to which history gives the name Reformation. Up to this time, young men were study-

ing their trivium and quadrivium in the cloister schools and cathedral schools. Scholastic philosophy had turned the activities of reason into unqualified support of the doctrines of religion. "New things seem now to take place upon the face of the earth. Copernicus discovers the sun-system, Columbus beholds another side of this great world, Magellan marks out the true form of the earth, Bacon applies his intellect to the formation of science." As we thus abruptly state these things, and as we consider their immense influence upon later history, it seems as though they came like new creations, suddenly thrust in upon the world's life, disconnected with all that preceded them, having no natural causes in the antecedent ages. It is the delightful task of history to present a *development*, to show the connections, be they ever so hidden, between the changing phenomena of human life. We may rest assured that not one among these startling events which make up the Reformation era is without its natural causes in the preceding times. Our task, however, is to follow education amid the changes that are taking place. Since religion was at the bottom of everything when the middle ages were closing, it follows, necessarily, that any radical reformation would appear first of all and most powerfully in religion. We know that the conflict which Luther brought to the daylight was a religious conflict, and we also realize that education could not be reached except through religion, as this was the supreme power controlling all the activities of men. Let us say, then, that the Church was divided into Catholic and Protestant. How was education affected by this division? Not so remarkably or beneficially as many would have expected. Luther, and those who worked with him, understood the power of education and wrote much upon the subject, yet they could not establish education rightly, and for a very plain reason. They needed help from the schools, they needed a training for their special teachings. The time was a time for self-defense. Therefore, after the Reformation had well set in, and after the reformers had established schools of all grades for their own children, we see no change in education except that it was made to support the Protestant religion in addition to the older faith. It was religion still with which education was vitally connected, and the reformers made no advance beyond the old scholastic system. When, therefore, we look at education after the Reformation was a fact, we find it still in the complete control of religion. We see two churches instead of one, and all the development or change that education could experience must be in the line of these church organizations.

In the Catholic Church education passed under the control of that wonderful order, the Jesuits. The Society of Jesus was a reformation within the Catholic Church, and the order exercised enormous influence. It reached directly into school and family, and made its teachings profoundly felt. These schools of the Jesuits taught, in addition to the ancient languages, mathematics, history, natural phi-

losophy, and paid special attention to good conduct and bodily exercise. The instruction was conducted by most perfect mechanism, the memory was inordinately developed, and obedience absolute. This system served the Church; and no better scholars, according to this standard, could be found than those who came from the institutes of the Jesuits.

The first condition for education is freedom—a freedom limited by nothing except the individual conscience and the rights of our fellow-men. Therefore any educational system established solely for the benefit of a special party or creed can have value for those persons only who, of choice, belong to the party, and of choice accept the creed. We have seen that middle-age training was exclusively a contra-earthly training. We have seen, also, that education was not allowed the necessary freedom by the reformers. Their liberty of conscience, as all know, was but slavery compared with the later and fuller realization. Our present point of outlook is the wide-spread attention given to the subject of education. The thing to be done is to sever education from its constrained, unnatural relation to the Church. During the last years of Luther's life (1546), this work was commenced by the two Germans Trotzendorf and Sturm. Most noticeable here is the unconsciousness of these men as to the significance of their undertaking. John Sturm was born at Schleiden in 1507. In 1537 he came to Strasburg, organized the gymnasium here, and remained as its rector from 1538 to 1583. It is said that the schools established by Sturm and under the direction of his teachers numbered many thousand students, among them pupils from Portugal, Poland, and England.

The central thing in all right education was, according to Sturm, the Latin language. Unlike Melanchthon, he wished Latin to be studied for *its own sake*, not for the Church. "He would secure for the German youth the same culture which distinguished the youths of Greece and Rome." Education is passing from the control of the Church to the control of Greece and Rome. This exchange was an advantage, though it was by no means the liberty which maketh free indeed. For centuries boys were to study Greek and Latin *nolens volens*, up, down, and all around. Here is the origin, the natural origin, of that supremacy of the classics in education which, inevitable and serviceable for many years, seeks in vain to maintain itself forever. We shall appreciate Sturm's system best by looking at the plan of his schools, which, fortunately, has been preserved.

"For the first seven years the mother shall bring up the child. At the seventh year the boy is brought to school. The school-training lasts nine years. Then begins the freer method, such as hearing lectures and practicing disputations. Of the nine classes which the scholar must pass through in nine years, seven classes and seven years are set apart for the mastery of the extra pure Latin speech, two

classes and two years to the acquisition of elegancies. Subsequently a tenth class was added; in this lowest class the basis was laid. Here the children learned the form and pronunciation of the letters, then reading, which can be better gained by Latin declensions and conjugations than by the catechism. In the ninth class the pupils were perfected in declension and conjugation, and grappled with the irregular verbs. At the same time a multitude of Latin words representing common objects were learned, and each pupil daily received a number of special words to be committed to memory. In the eighth class the first thing to be considered was that the boy forgot nothing of what he had learned in the preceding classes. Those who entered this class must be able to parse all leading words and adverbs. This they learned more through practice than in any scientific manner, as the Roman and Greek boys exercised themselves in speech before the grammar was given them. In this eighth class the separate declensions and conjugations were distinguished and marked by examples which the scholars could take from the words already learned. Then Cicero's letters were to be translated with sole reference to the grammar. Some practice in style appears for the first time during the last months of the year; there were oral exercises in the formation of new Latin phrases, and the transposition of those already assigned.

"The seventh class takes special care that nothing is forgotten; then Latin syntax is dealt with in simple rules—these rules are explained by Ciceronian examples. Each day Cicero's letters are read, for in this class they must read much in order to gain much. The themes for practice in style are selected from that which the pupil has learned in this or the preceding classes, thus making these themes a refreshment of the memory. The teacher must help his pupils orally and by writing on the blackboard. On Sunday the German catechism is translated into classical Latin.

"Since the preservation of what is learned is no less an art than learning anew, the sixth class must not forget anything. Longer letters of Cicero are now translated into German, and different letters are given to companies of ten. In like manner various poetical pieces are assigned to different pupils; the Andria of Terence and the first poetical volume are read. In connection with writing, the pupils are compelled to pay special attention to the minute development of their style. Saturday evenings and Sundays they continue translation of the catechism; some letters of Jerome are read, and Greek is commenced. From the fifth class onward the scholars are made acquainted with the less-known words and their objects. Metrical composition is studied, and in the later months of the year this is joined with some practical exercises. Then mythology is taken up; Cicero's Lælius and Virgil's Eclogues are read. In Greek the pupils learn to name the virtues and vices and habits of men; they write them down carefully in their dictionary. Style must be further de-

veloped, and at the same time something oratorical is read, which has been retranslated into Latin. Saturday evenings and Sundays the shorter letters of Paul are studied.

"In the fourth class the scholar hears as much as possible, interprets, memorizes, and recites, but nothing that goes beyond his power. Select letters and compositions from Horace are read, then everything learned in the preceding classes is repeated. Saturday evenings and Sundays the pupil himself gives simple paraphrased explanations of Paul's letters. In the third class they retain what has been learned and enlarge upon it. The ornaments of rhetoricians, such as tropes and figures, are explained and illustrated. In Greek the better orations of Demosthenes are read, then the first book of the Iliad, followed by exercises in style. Some parts of the Greek orations are translated into Latin, or the Latin into Greek. The odes of Pindar and Horace are set to other metre; many poems are made and many letters written. The comedies of Plautus and Terence are brought out, and the boys compete with the higher classes. In the second class the boys are obliged to interpret Latin and Greek orators literally, so that the teacher simply calls attention to the relation of the oratorical and political usage, and requires the pupils to enter in their day-books all remarkable portions of the author. The same thing is done with the Latin writers, and these are compared with the Greek. Dialectic, the instrument of the truth, is now put into the pupil's hands; at first only the critical part, later the figurative, then rhetoric, which must always be at the side of the scholar. The Olynthiac and Philippic orations of Demosthenes are read in their bearing upon rhetoric, and the pupils are allowed to make their own selections. There are daily style exercises, and with them some short declamations which are written down by the scholars and then learned *verbatim*. On Sunday the Epistle to the Romans is read and learned, and repeated *verbatim* by all. The first class continues rhetoric and dialectic. The citation of dialectic and rhetorical rules must be proved out of Demosthenes and Cicero. Homer and Virgil are read further, and Thucydides is translated into writing; no week passes without providing some plays. The Epistles of Paul are explained by the pupils, and selected portions are enlarged upon according to rhetorical rules."

These schools of Sturm contained no history, no geography, no natural history, no physics, no elementary instruction in the German language. Arithmetic was taught only in the second class; some few sentences from the first book of Euclid and the elements of astronomy were learned in the first class. The motto was Ciceronian Latin. The problem was to turn a boy into an automatic Latin machine, capable of clicking out Ciceronian sentences. Education approximated ideal perfection in proportion as it reproduced the Latin speech. Sturm, doing education great service, did it also serious harm. Ciceronian Latin—

this was the phrase that, like a curse, blighted the harmonious development of thousands of youth; the phrase that has carried over into our times such excessive zeal for the classics as has materially assisted to produce the present reaction. In saying this, we pronounce no opinion for or against the continuance of classical training in the college course of study. What may be said on that subject in these papers will appear elsewhere; our present purpose is to show historically the natural, necessary origin of that supremacy of Greek and Latin which many would maintain at all hazard.

The reformers did a great work, both directly and indirectly, for education. They failed to the extent that their idea of man was faulty. They did not understand the liberty which they proclaimed, yet they caused to be brought to light a most important problem, viz., the separation of religion, as dogma, from education—a separation which must take place before there can be any true union. Here was the indirect influence of the Reformation; its direct bearing upon education is found in the fact that this subject now became special matter for thought and endeavor. The Jesuits and the Lutherans systematized education as thoroughly as could be done in the interests of a dogmatic theology. We have seen the beginnings of the reaction. The schools of Sturm taught Latin and Greek for Latin and Greek's sake—not for Church or party. Here was the first step, right, indeed, for its time; a most serious misstep, however, for the remote future. A way had been opened for thought; and where thought begins there will be change; where thought continues there will be progress. Now men are directly at work to improve the methods of education. We have reached the time of individual and conscious effort.

We are concerned rather with general movements than with men, and for this reason shall refer to leading educators only so far as may be necessary to illustrate the evolution of our subject. Wolfgang Ratich was born at Wilster, in Holstein, October 18, 1571. In Holland he determined to appear as a reformer of the entire method of teaching the languages. His estimation of himself and what he could accomplish was altogether incredible: "I will give to my Fatherland and to all Christendom a remarkable service, and I will bestow upon them a most inexpressible advantage. Inside of eight or ten days I will disclose, in a strictly confidential manner, my method of languages. I will make known what amount in every language can be scientifically taught, learned, and spread abroad in one half year, as well by the old as the young, as well by women as children; and this, too, completely not piece-wise." Ratich was, as these words show, very much of a charlatan; still, he gained the attention of many influential men—among them Prince Ludwig and the Duke of Saxe-Weimar—and extraordinary efforts were made to reform the schools and methods of instruction. We need not dwell upon the miserable failure of this

undertaking, as far as respects any established instruction. The school, which was opened June 21, 1619, received the censure of the school inspectors on July 28th of the same year, and in October the reformer was cast into prison. Among the ideas generally accredited to Ratich as his own, the following are significant: "Education is a common, thorough-going work, and no one is to be shut out from it; every one must, at least, be capable of reading and writing. The young may be instructed in only one language or study at the same time; before this has been learned, they may not take up another. Everything must proceed according to the order of Nature, who, in all her arrangements, is wont to advance from the simpler and lower to the larger and higher. All subjects must be proceeded with in a twofold manner: first, they must be seized in outline or abbreviation; afterward, they should be comprehended and taught with more complete instruction." This brief account of Ratich furnishes clear evidence that attention was now given to education in remarkable degree. It shows the presence of new and true principles in the educational question, as witness the last quotations. Further, this account strikingly confirms our statements in the first paper, where the distinction was drawn between a scientific treatment of education and an enunciation of educational principles.

We now, and for the first time, meet an avowed attempt to treat education *philosophically*—that is, to apply ideas concerning man's nature to his education. This attempt was made by John Amos Comenius, born at Comnia, in Moravia, 1592. Comenius was every way great-minded, and had it thoroughly in him to teach. All philosophy has been and will continue to be distinguished by two fundamentally opposed methods. For our present purpose, we may characterize these methods by the terms intuitive and experimental. According to the first method, man, in his spiritual nature, contains the truth—*is* the truth. The idea, the reason, is alone permanent and real. According to the second method, man is dependent on an external world for the origin, continuance, and verification of *all* his knowledge. As related through the senses to nature, man is capable of reasoning and of correcting his conclusions. He brings no knowledge with him into the world. He is a power, or series of powers, to be awakened through the senses. It was the mission of Comenius to apply this inductive, experimental method to education.

For him, therefore, there was but one procedure in education, viz., *development of the natural capacities.* Education was an unfolding, not of original *knowledge* but of original *powers*, and this by such means as the senses furnished. A moment's reflection shows that his method directly antagonizes middle-age, Lutheran, and Calvinistic orthodoxy. The point of antagonism is the doctrine of man's condition as produced by the fall. Original sin had made man through and through bad, good for—*nothing;* how, then, could any educa-

tional system which proceeded upon no other plan than the development of man's capacities be other than false, disastrous, condemnable? Comenius saw clearly this opposition between his fundamental principle and orthodoxy, and endeavored to meet the difficulty by saying that man's fall did not utterly destroy his original powers, but weakened them, leaving it possible to secure a beneficial development. This reconciliation was no reconciliation, and the fault lay in the nature of the case, not in Comenius; all adjustment between these opposing views is impossible.

The words of Comenius, respecting the education of woman, are of special significance, and this alike from their time and their character. He said: "There is no reason why woman should be excluded from culture, either from that which comes through the Latin language or through the native tongue. Women also are images of the Godhead, and possess spiritual receptivity and capacity for training, often more than we—they too are often summoned to great work. Why should we let them come to the alphabet and then cast them away from books? Do we fear superficiality? But, the more thoughts a person gains, the less room is there for superficiality which always comes from spiritual emptiness." When we ask how Comenius dealt with education, we are to remember that he proceeded according to a philosophy of the matter. He had something to say about man before giving rules for his training. He consciously adopted that principle which we have affirmed to be essential, viz., that the idea man has of himself must determine his education. Comenius had an idea of man, and made it the guiding principle in his system. Man, so he maintained, lives a threefold life, a vegetative, an animal, and a rational or spiritual life. He has a threefold home—the mother, the earth, the heaven. By birth he enters his second home, by death and resurrection his third and eternal home. In the first we receive simply life with its movements and senses, in the second we gain life and the senses with rationality, in the third we reach the fulfillment of all things. That first life is a preparation for the second, the second a preparation for the third, the third is without end. Compare this understanding of man with the middle-age teaching. Here man is incarcerated in a body and dungeoned on the earth; for Comenius, man is provided with an organism and placed at school for the unfolding of his nature in an endless progress. According to the one view, man is to cast away his body as a thing accursed; according to the other, he is to use it as an instrument unto life.

Careful study of the writings of Comenius can not fail to impress one with the *naturalness*, that is, the *truth* of his method. From beginning to end his thought is an attempt to follow Nature, and this not after the impossible manner of Rousseau's "Émile," but by a patient scrutiny of natural processes everywhere appearing. Man is one with Nature, and, as so, Nature will show him how to educate himself—not,

will educate him—a distinction that requires full emphasis. In illustration of what has here been said, I translate a few passages from the works of Comenius:

"The *order* of instruction must be learned from Nature. Hence it follows that education has, first of all, to set forth and keep firm hold of the fundamental principles for the *preservation of life*, that the necessary time may be given to a course of instruction. We must guard the body from disease and deadly accident, because it is the only temporal residence of the soul, and because it *is the instrument of the rational spirit.* (Italics are the present writer's.)

"Nature waits, in all her undertakings, for the suitable time. So must we seize the right time for the discipline of the mind, and must *carry out this discipline progressively.* Training should begin in childhood, the spring-time of life; it should be prosecuted in the morning hours, the spring-time of the day; and that only should be learned *which is adapted to the capacity of apprehension.*" This simple sentence, had it been able to prevail from the time at which it was written, would have prevented the blank horror on many a youthful countenance as it faced the statement that "a noun and participle are put into the ablative called absolute to denote the time, cause, manner, means, the concomitant of an action, or the condition on which it depends."

To return to Comenius: "Nature first prepares the material, then gives it a form. The architect follows the same principle: he brings together all that is necessary for the building, and then works his material. Corresponding to this, we must have at hand in the schools all needful books and every appliance. *We must cultivate the understanding before the languages. We must teach no language from grammar but from its writers, and we must allow the experimental sciences to precede the organic.*

"Nature begins every one of her works from within. The bird proceeds from within outward. The tree draws its nourishment through the pores of the inner part; it grows from within. Likewise in education this requirement stands fast: *first help to gain an insight into the things, then cultivate the memory.*

"Nature begins all her works with the most universal and ends with the particular. When she builds a bird, she draws through the warmed mass a film, that an outline of the entire bird may arise. Then *and for the first time* she shapes each particular portion. The architect imitates this method. First he makes the tracing, then lays the foundation. The painter does the same. He does not at first paint a complete ear, but makes an outline of the countenance and then paints it in. Accordingly, the youth who give themselves to study must, *in the very first part* of their training, lay the groundwork of a *universal culture.* The objects of pursuit must be so ordered that the later studies will not appear to bring anything new, but sim-

ply the development of that which has been given into its distinguishing features. Every language, science, and art, must begin with the most simple rudiments, in order that the idea of the whole may arise; *then* follow the *rules.*

"Nature makes no leap, but advances step by step. The bird first tries her wings on the nest, after that from branch to branch, later from tree to tree, at last freely through the air. Corresponding to this the studies must be brought into an order, that the earlier may serve as introductions to the later, may mark out a pathway. The one who is to be instructed *must see himself learn.* Therefore everything should be conducted according to its immovable principles. *Nothing should be taught on simple authority; everything must be subjected to the test of the senses and the proof of reason.* It is a golden rule of life—represent everything to the senses; that which can be seen to the sight, that which can be heard to the hearing, and that which can be felt to the touch. The beginning of knowledge necessarily proceeds from the senses. The truth and certainty of knowledge depend upon the testimony of the senses. Eye-sight stands for proof."

Any reflection upon these words of Comenius makes it clear that his system proceeds from a sound view of human nature and of the task of education. The philosophical ideas originated elsewhere, as in England and France, were applied by Comenius to education. He did this work in no servile way, but fearlessly and well.

It is possible that we are in danger of drawing wrong conclusions with respect to the amount and extent of improvement thus far actually effected in education. Considering only the true principles set forth by the reformers Ratich and Comenius, and remembering also how frequently these men were summoned to amend the school systems, we might naturally conclude that the work was done; we might believe that education had been rescued from its paralysis in the Church and its mechanism under Sturm. Nothing, however, could be more wide of the mark than such a conclusion. The law of progress is here a little and there a little. Though Sturm and Ratich and Comenius and Bacon and Montaigne and Locke had spoken and spoken truth, the truth prevailed not; could not prevail until there was added to its simple articulation in language the irresistible force of events; until scientific discovery, pervading and bettering society, made men heed the manner and course of Nature.

We need to hold clearly in mind the exact work to be done. It was to secure for man as man a freedom for development limited by nothing save an enlightened conscience and the rights of his fellows. Representative men had begun this work. The masses of the people, however, went on their way as of old, and another unlooked-for step was to be taken before the right path appeared.

THE MICROBES OF ANIMAL DISEASES.*

By E. L. TROUESSART.

THE first of the virulent and contagious diseases in which the presence of a microbe was positively ascertained was anthrax, or splenic fever, which attacks most of our horned animals, and especially cattle and sheep.

As early as 1850, Davaine had observed the presence of minute rods in the blood of animals which died of splenic fever; but it was only in 1863, after Pasteur's first researches into the part played by microbes in fermentations, that Davaine suspected these rods of being the actual cause of the disease. He inoculated healthy animals with the tainted blood, and thus ascertained that even a very minute dose would produce a fatal attack of the disease, and the rods, to which he gave the name of *Bacteridia*, could always be discovered in enormous numbers in the blood.

The microbe so named by Davaine must from its characteristics be assigned to the genus Bacillus, and is now termed *Bacillus anthracis*. This disease, which affects men as well as animals, is characterized by general depression, by redness and congestion of the eyes, by short

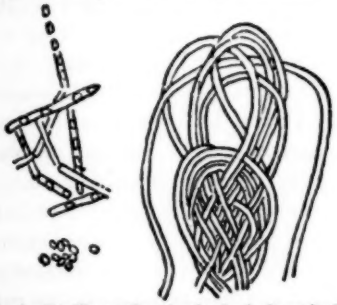

FIG. 1.—*Bacillus anthracis* of splenic fever in different stages of development; bacilli, spores, and curled filaments (much enlarged).

FIG. 2.—*Bacillus anthracis*, produced in Guinea-pig by inoculation; corpuscles of blood and bacilli.

and irregular respiration, and by the formation of abscesses, which feature, in the case of the human subject, has procured for it the name of malignant pustule. The disease is quickly terminated by death, and an autopsy shows that the blood is black, that intestinal hæmorrhage has occurred, and that the spleen is abnormally large, heavy, and gorged with blood; hence the name of splenic fever. The disease is generally inoculated by the bite of flies which have settled upon carcasses and absorbed the bacteria, or by blood-poisoning through some accidental scratch, and this is especially the case with

* From "Microbes, Ferments, and Molds." By E. L. Trouessart. Vol. lvi, "International Scientific Series." New York: D. Appleton & Co. 1886.

knackers and butchers who break and handle the bones of animals which have died of anthrax.

The period of incubation is very short. An ox which has been at work may return to the stall apparently healthy. He eats as usual; then lies down on his side and breathes heavily, while the eyes are still clear. Suddenly his head drops, his body grows cold; at the end of an hour the eye becomes glazed; the animal struggles to get up, and falls dead. In this case, the illness has only lasted for an hour and a half (Empis).

In order to prove that the disease is really caused by *Bacillus anthracis*, Pasteur inserted a very small drop of blood, taken from an animal which had recently died of anthrax, in a glass flask which contained an infusion of yeast, neutralized by potassium and previously sterilized. In twenty-four hours the liquid, which had been clear, was seen to be full of very light flakes, produced by masses of bacilli, readily discernible under the microscope. A drop from the first flask produced the same effect in a second, and from that to a third, and so on. By this means the organism was completely freed from all which was foreign to it in the original blood, since it is calculated that, after from eight to ten of such processes, the drop of blood was diluted in a volume of liquid greater than the volume of the earth. Yet the tenth, twentieth, and even the fiftieth infusion would, when a drop was inserted under the skin of a sheep, procure its death by splenic fever, with the same symptoms as those produced by the original drop of blood. The bacillus is, therefore, the sole cause of the disease.

These cultures have often since been repeated by numerous observers, so that the microbe has been studied in all its forms, and the extent of its polymorphism has been ascertained. At the end of two days the bacterium, which, while still in the blood, is of a short abrupt form, displays excessively long filaments, which are sometimes rolled up like a coil of string. In about a week many of the filaments contain refracting, somewhat elongated nuclei. These nuclei presently form chaplets, in consequence of the rupture of the cell-wall of the rod which gave birth to them; others, again, float in the liquid in the form of isolated globules. These nuclei are the spores or germs of the microbes, which germinate when placed in the infusion, become elongated, and reproduce fresh bacilli.

These spores are much more tenacious of life than the microbes themselves. The latter perish in a temperature of 60°, by desiccation, in a vacuum, in carbonic acid, alcohol, and compressed oxygen. The spores, on the other hand, resist desiccation, so that they can float in the air in the form of dust. They also resist a temperature of from 90° to 95°, and the effects of a vacuum, of carbonic acid, of alcohol, and compressed oxygen.

In 1873 Pasteur, aided by Chamberland and Roux, carried on some experiments on a farm near Chartres, in order to discover why this dis-

ease is so common in some districts, in which its spread can not be ascribed to the bite of flies. Grass, on which the germs of bacteridia had been placed, was given to the sheep. A certain number of them died of splenic fever. The glands and tissues of the back of the throat were very much swelled, as if the inoculation had occurred in the upper part of the alimentary canal, and by means of slight wounds on the surface of the mucous membrane of the mouth. In order to verify the fact, the grass given to the sheep was mixed with thistles and bearded ears of wheat and barley, or other prickly matter, and in consequence the mortality was sensibly increased.

In cases of spontaneous disease it was surmised that the germs which were artificially introduced into food in the course of these experiments are found upon the grass, especially in the neighborhood of places in which infected animals had been buried. It was, in fact, ascertained that these germs existed above and around the infected carcasses, and that they were absent at a certain distance from their burial-place. It is true that putrid fermentation destroys most of the bacteria, but before this occurs a certain number of microbes are dispersed by the gas disengaged from the carcass; these dry up and produce germs, which retain their vitality in the soil for a long while.

The mechanism by means of which these germs are brought to the surface of the soil and on to the grass on which the sheep feed is at once simple and remarkable. Earth-worms prefer soils which are rich in humus or decomposing organic substance, and seek their food round the carcass. They swallow the earth containing the germs of which we have spoken, which they deposit on the surface of the soil, after it has traversed their intestinal canals, in the little heaps with which we are all acquainted. The germs do not lose their virulence in their passage through the worms' intestines, and, if the sheep swallow them together with the grass on which they browse, they may contract the disease. The turning-up of the soil by the spade or plow may produce the same effect.

A certain warmth is necessary for the formation of germs; none are produced when it falls below 12°, and the carcasses buried in winter are therefore less dangerous than those buried in the spring and summer. It is, in fact, in hot weather that the disease is most prevalent. Animals may, however, contract it even in their stalls from eating dry fodder on which germs of these bacteria remain.

Pasteur and his pupils performed an experiment in the Jura in 1879, which clearly shows that the presence of germs above the trenches in which carcasses have been buried is the principal cause of inoculation. Twenty oxen or cows had perished, and several of them were buried in trenches in a meadow where the presence of these germs was ascertained. Three of the graves were surrounded by a fence, within which four sheep were placed. Other sheep were folded within a few yards of the former, but in places where no infected animals had been buried.

At the end of three days three of the sheep folded above the graves had died of splenic fever, while those excluded from them continued to be healthy. This result speaks for itself.

Malignant pustule, which is simply splenic fever, affects shepherds, butchers, and tanners, who handle the flesh and hide of tainted animals. Inoculation with the bacillus almost always occurs in consequence of a wound or scratch on the hands or face. In Germany, fatal cases of anthrax have been observed, in which the disease has been introduced through the mouth or lungs, as in the case of the sheep observed by Pasteur. The human subject appears, however, to be less apt to contract the disease than herbivora, since the flesh of animals affected by splenic fever, and only killed when the microbe is fully developed in the blood, is often eaten in farm-houses. In this case the custom prevalent among French peasants of eating overcooked meat constitutes the chief safeguard, since the bacteria and their germs are thus destroyed.

The rapidity with which anthrax is propagated by inoculation generally renders all kinds of treatment useless: if, however, the wound through which the microbe is introduced can be discovered, it should be cauterized at once. This method is often successful in man. The pustule is cauterized with red-hot iron, or with bichloride of mercury and thymic acid, two powerful antiseptics, certain to destroy the bacteridium. It is expedient, as a hygienic measure, to burn the tainted carcasses, and, if this is not done, they should be buried at a much greater depth than is usually the case.

But the preservative means on which chief reliance is now placed is vaccination with the virus of anthrax. Pasteur has ascertained that when animals are inoculated with a liquid containing bacteridia of which the virulence has been attenuated by culture carried as far as the tenth generation, or even further, their lives are preserved. They take the disease, but generally in a very mild form, and it is an important result of this treatment that they are henceforward safe from a fresh attack of the disease; in a word, they are *vaccinated* against anthrax.

In the cultures prepared with the view of attenuating the microbe, it is the action of the oxygen of the air which renders the bacteridium less virulent. It should be subjected to a temperature of from 42° to 43° in the case of *Bacillus anthracis*, to enable it to multiply, and at the same time to check the production of spores which might make the liquid too powerful. At the end of the week, the culture, which at first killed the whole of ten sheep, killed only four or five out of ten. In ten or twelve days it ceased to kill any; the disease was perfectly mild, as in the case of the human vaccinia. After the bacteridia have been attenuated, they can be cultivated in the lower temperature of from 30° to 35°, and only produce spores of the same attenuated strength as the filaments which form them (Chamberland).

The vaccine thus obtained in Pasteur's laboratory is now distributed throughout the world, and has already saved numerous flocks from almost certain destruction. Although this process has only been known for a few years, its results are such that the gain to agriculture already amounts to many thousands of pounds.

Toussaint makes use of a slightly different mode of preparing a vaccine virus, which is, however, analogous to that of Pasteur. He subjects the lymph of the blood of a diseased animal to a temperature of 50°, and thus transforms it into vaccine. Toussaint considers the high temperature to be the principal agent of attenuation, and ascribes little or no importance to the action of the oxygen in the air.

Chamberland and Roux have recently made researches with the object of obtaining a similar vaccine by attenuating the primitive virus by means of antiseptic substances. They have ascertained that a solution of carbolic acid of one part in six hundred destroys the microbes of anthrax, while they can live and flourish in a solution of one part in nine hundred, but without producing spores, and their virulence is attenuated. When a nourishing broth is added to a solution of one in six hundred, the microbe can live and grow in it for months. Since the chief condition of attenuation consists in the absence of spores, this condition seems to be realized by the culture in a solution of carbolic acid, one in nine hundred, and it is probable that a fresh form of attenuated virus may thus be obtained. Diluted sulphuric acid gives analogous results. However this may be, the vaccine prepared by Pasteur's process is the only one which has been largely used, and which has afforded certain results to cattle-breeders.

Public experiments, performed before commissions composed of most competent men, have clearly shown the virtue of the protective action. In the summer of 1881 the initiation was taken by the Melun Society of Agriculture. Twenty-five sheep and eight cows or oxen were vaccinated at Pouilly-le-Fort, and then reinoculated with blood from animals which had recently died of anthrax, together with twenty-five sheep and five cows which had not been previously vaccinated. None of the vaccinated animals suffered, while the twenty-five test sheep died within forty-eight hours, and the five cows were so ill that the veterinary surgeons despaired of them for several days.

This experiment was publicly repeated in September, 1881, by Thuillier, Pasteur's fellow-worker, whose death we have recently had to deplore, before the representatives of the Austro-Hungarian Government; and again near Berlin, in 1882, before the representatives of the German Government, and always with the same success. Up to April, 1882, more than one hundred and thirty thousand sheep and two thousand oxen or cows had been vaccinated; and since that time the demand for vaccine from Pasteur's laboratory has reached him from every quarter.

The sickness of barn-door poultry, which is commonly called cholera, is caused by the presence in the blood of a small micrococcus or bacterium in the form of the figure 8, differing, therefore, in form from *Bacillus anthracis*, but also an aërobie. It may be cultivated in chicken-broth, neutralized by potash, while it soon dies in the extract of yeast, which is so well adapted to *Bacillus anthracis*. The microbe of this disease may also be attenuated by culture, and it may be done more easily than in the case of anthrax, since it is not necessary to raise the temperature, as the bacterium of fowl-cholera does not produce spores under culture. Pasteur has therefore been able to prepare an attenuated virus well adapted to protect fowls from further attacks of this disease.

The disease affecting swine, which is called *rouget*, or swine-fever, in the south of France, has been recently studied by Detmers in the United States, where it is also very prevalent, and by Pasteur in the department of Vaucluse. It is a kind of *pneumo-enteritis*. These observers consider that the disease is caused by a very slender microbe, formed, like that of fowl-cholera, in the shape of the figure 8, but more minute. Others say that there is a bacillus which was observed by Klein as early as 1878 in swine attacked by this disease. In spite of the apparent contradiction, it is probable that we have only two forms of the same microbe, for the bacillus in Klein's culture at first

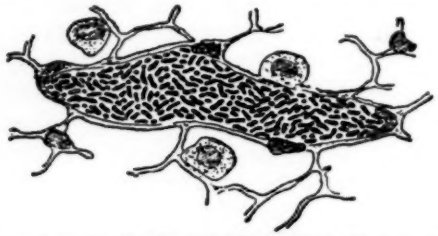

FIG. 3.—SWINE FEVER: section of a lymphatic gland, showing a blood-vessel filled with microbes (much enlarged). (Klein.)

resembles *Bacterium termo*, in the form of an 8, before it is elongated into rods. Pasteur has succeeded in making cultures of microbes in the figure 8. He has inoculated swine with the attenuated form, after which they have been able to resist the disease, so there is reason to hope that in the near future this new vaccine, containing the attenuated microbe, may become the safeguard of our pig-sties.

An epidemic which raged in Paris in 1881 was called the typhoid fever of horses, and was fatal to more than fifteen hundred animals belonging to the General Omnibus Company in that city. This disease is also produced by a microbe, with which Pasteur was able to inoculate other animals (rabbits); for this purpose he made use of the serous discharge from the horses' nostrils. The inoculated rabbits died with all the symptoms and lesions characteristic of the disease. The attenuation of this microbe by culture is difficult, since at the end of a

certain time the action of the air kills it. Pasteur has, however, found an expedient by which to accomplish his purpose. When the culture is shown to be sterile in consequence of the death of the microbe, he takes as the mother-culture of a fresh series of daily cultures the one which was made on the day preceding the death of the first mother-culture. In this way he has obtained an attenuated virus with which to inoculate rabbits, and the same result might undoubtedly be obtained in the case of horses.

There are many other contagious diseases which affect domestic animals, and which are probably due to microbes, such as, for instance, the infectious pneumonia of horned cattle. This was probably the first disease in which the protective effects of inoculation were tried, according to Wilhelm's method. This method consisted in making an incision under the animal's tail with a scalpel dipped in the purulent mucus or blood taken from the lung of a beast which had died of pneumonia; sometimes the serous discharge from the swelling under the tail of an inoculated animal was used for others. Fever and loss of appetite ensued, lasting from eight to twenty-five days, but the animal was afterward safe from further attacks of the disease. Cattle-plague, or contagious typhus, is likewise ascribed to the presence of a microbe with which we are as yet imperfectly acquainted.

Experimental septicæmia is entitled to special mention, since it has too often been confounded with anthrax, and has been unskillfully produced with the intention of vaccinating animals in accordance with Pasteur's process. This occurs when too long an interval (twenty-four hours) elapses after the death of an animal, before taking from it the blood intended for vaccine cultures. After this date the blood no longer contains *Bacillus anthracis*, which is succeeded by another microbe termed *Vibrio septicus*, differing widely from the anthrax microbe in form, habit, and character (Fig. 4). *Bacillus anthracis* is straight and immobile, while the septic vibrio is sinuous, curled, and mobile.

FIG. 4.—*Septic vibrio*, bacillus of malignant œdema (Koch): *a*, taken from spleen of Guinea-pig; *b*, from a mouse's lung.

Moreover, it is anaërobic, and does not survive contact with the air, but it thrives in a vacuum or in carbonic acid. Since *Bacillus anthracis* is, on the other hand, an aërobic, it is clear that the two microbes can not exist simultaneously in the blood or in the same culture-liquid. The inoculation with this fresh microbe is no less fatal; its action is even more rapid than that of *Bacillus anthracis*, but the lesions are not the same; the spleen remains normal, while the liver is discolored. The septic vibrio is only found in minute quantities in the blood, so that it has escaped the notice of many observers. It is, however, found in immense numbers in the muscles, in the serous fluid of the intestines,

and of other organs. It is very common in the intestines, and is probably the beginning of putrefaction.

Rabies is a canine disease which is communicated by a bite, and the inoculation of man and other animals by the saliva. We are not yet precisely acquainted with the microbe which causes the disease, but Pasteur's recent researches have thrown considerable light on its life-history, which is still, however, too much involved in obscurity. It must first be observed that the hypothetical microbe of rabies, which no one has yet discovered, should not be confounded with the microbe of human saliva; this is found in the mouths of healthy persons.

The following conclusions are the result of Pasteur's researches into the virus of rabies.

This virus is found in the saliva of animals and men affected by rabies, associated with various microbes. Inoculation with the saliva may produce death in three forms: by the salivary microbe, by the excessive development of pus, and finally by rabies. The brain, and especially the medulla oblongata, of men and animals which have died of rabies, is always virulent until putrefaction has set in. So also is the spinal cord. The virus is, therefore, essentially localized in the nervous system. Rabies is rapidly and certainly developed by trephining the bones of the cranium, and then inoculating the surface of the brain with the blood or saliva of a rabid animal. In this way there is a suppression of the long incubation which ensues from simple inoculation of the blood by a bite or intravenous injection on any part of the body. It is probable that in this case the spinal cord is the first to be affected by the virus introduced into the blood; it then fastens on its tissues and multiplies in them.

As a general rule, a first attack which has not proved fatal is no protection against a fresh attack. In 1881, however, a dog, which had displayed the first symptoms of the disease of which the other animals associated with him had died, not only recovered, but failed to take rabies by trephining, when reinoculated in 1882. Pasteur is now in possession of four dogs which are absolutely secured from infection, whatever be the mode of inoculation and the intensity of the virus. All the other test-dogs which were inoculated at the same time died of rabies. In 1884, Pasteur found the means of attenuating the virus. For this purpose he has inoculated a morsel of the brain of a mad dog into a rabbit's brain, and has passed the virus proceeding from the rabbit through the organism of a monkey, whence it becomes attenuated and a protective vaccine for dogs. This is the first step toward the extinction of this terrible disease.

Glanders, again, is a disease easily transmitted from horses to man. Glanders, or farcy, is caused by the presence of a bacterium, observed as early as 1868 by Christot and Kiener, and more recently studied at Berlin by Schütz and Löfler. This microbe appears in the form of very fine rods (*bacillus*) in the lungs, liver, spleen, and nasal cavity.

Babès and Havas found this bacillus in the human subject in 1881. Experimental cultures have been made simultaneously in France and Germany, and have given identical results.

Bouchard, Capitan and Charrin made their cultures in neutralized solutions of extract of meat, maintained at a temperature of 37°. By means of successive sowings, they have obtained the production of unmixed microbes, presenting no trace of the original liquid, and this was done in vessels protected from air-germs. These cultures may be carried to the eighth generation. Asses and horses inoculated with liquid containing the microbes produced by this culture have died with the lesions characteristic of glanders (glanderous tubercles in the spleen, lungs, etc.). Cats and other animals which have been inoculated in the same way die with glanderous tubercles in the lymphatic glands and other organs.

It follows from these experiments that the microbe which causes this disease is always reproduced in the different culture-liquids with its characteristic form and dimensions; that uni-ungulates can be inoculated with it, as well as man and other animals. In fact, this microbe is the essential cause of the disease.

We have already spoken of muscardine, a silk-worm's disease produced by a microscopic fungus; two other diseases are caused by distinct microbes, of which we must shortly speak. In the silk-worm nurseries, in which this disease prevails, the silk-worms which issue from the eggs, technically called seed, are slowly and irregularly developed, so as to vary greatly in size. Many die young, and those which survive the fourth molt shrink and shrivel away; they can hardly creep on to the heather to spin their cocoon, and produce scarcely any silk.

On an examination of the worms which have died of this disease, De Quatrefages ascertained the presence of minute stains on the skin and in the interior of the body, which he compared to a sprinkling of black pepper; hence the name *pebrine*. Under the microscope these stains assume the form of small mobile granules like bacteria, which Cornalia termed vibratile corpuscles, on account of their movements. Finally, Osimo and Vittadini ascertained the existence of these corpuscles in the eggs, and consequently showed that the epidemic might be averted by the sole use of healthy eggs, of which the soundness should be established by microscopic examination.

It was at about this date (1865) that Pasteur undertook the exhaustive study of pebrine; but Béchamp was the first to pronounce the disease parasitic, resembling muscardine in this respect, and caused by the attacks of a microbe—or microzyma, to adopt Béchamp's name—of which the germ or spore is derived from the air, at first attacking the silk-worm from without, but multiplying in its interior, and developing with its growth, so that the infected moth is unable to lay its eggs without depositing the spores of the microbe at the same time,

and thus exposing the young grub to attack as soon as it is born. Pasteur's own researches soon induced him to adopt the same view. The pebrine microbe was long regarded as a true bacterium, successively described as *Bacterium bombycis*, *Nosema bombycis* (Fig. 5), and *Panistophyton ovale*. Balbiani's recent researches tend to show that it should be assigned to another group, much nearer to animals, and designated *Sporozoaria*. These protista, still regarded as plants by many naturalists, chiefly differ from bacteria by their mode of growth and reproduction, in which they resemble the parasitic protozoaria, termed *Psorospermia*, *Coccidies*, and *Gregarinidæ*.

FIG. 5.—*Nosema bombycis*, pebrine microbe (× 500 diam.).

In *Sporozoaria*, growth by fission, the rule in all bacteria, has not been observed; this distinction is fundamental. Sporozoaria multiply by free spore-formation in a mass of sarcode substance (protoplasm), resulting from the encysting of the primitive corpuscles (mother-cells). The formation of numerous spores may be observed within the mother-cells, having the appearance of *pseudonavicellæ* or spores of gregarinidæ and psorospermia (parasites of vertebrate animals). Balbiani forms these organisms, which are found in many insects, into a small group, which he terms *Microsporidia*.

The ripe spores are the vibratile corpuscles of Cornalia. They closely resemble the spores of some bacilli (*B. amylobacter*, for instance), and their germination is likewise effected by perforation of the spore at one end, and issue of the protoplasm from the interior. This, however, does not issue in a rod-like form (*Bacillus*), but in that of a small protoplasmic mass, with amœboid movements, a characteristic not observed in any bacterium (Balbiani). The other species of silk-worms which have been recently introduced, notably the oak silk-worm from China (*Attacus Pernyi*), are attacked by microsporidia analogous to those of pebrine.

Pasteur has indicated the mode of averting the ravages of this disease. He has thus addressed the breeders: "If you wish to know whether a lot of cocoons will yield good seed, separate a portion of them and subject them to heat, which will accelerate the escape of the moth by four or five days, and examine them under the microscope to ascertain whether corpuscles of pebrine are present. If they are, send all the cocoons to the silk-factory. If they are not diseased, allow them to breed, and the seed will be good and will hatch out successfully. In a word, start with absolutely healthy seed, produced by absolutely pure parents, and rear them under such conditions of cleanliness and isolation as may insure immunity from infection." When the disease is developed, fumigation with sulphurous acid is recommended, or preferably with creosote or carbolic acid, which do not affect the silk-worms (Béchamp), and which hinder the development of microsporidia. These fumigations likewise keep the litter from

becoming corrupt, and in a properly conducted nursery the litter is kept dry.

Wrongly confounded with pebrine, the disease *flacherie* is still more destructive to silk-worms. The symptoms are remarkable. The rearing of silk-worms often goes on regularly up to the fourth molt, and success seems assured, when the silk-worms suddenly cease to feed, avoid the leaves, become torpid, and perish, while still retaining an appearance of vitality, so that it is necessary to touch them in order to ascertain that they are dead. In this state they are termed *morts-flats*. A few days, sometimes even a few hours, suffice to transform the most flourishing nursery into a charnel-house. Pasteur examined these *morts-flats*, and found that the leaves contained in the stomach and intestine were full of bacteria, resembling those which are developed when the leaves are bruised in a glass of water and left to putrefy (Fig. 6). In a healthy specimen, of good digestion, these bacteria are never found. It is therefore evident that the disease is owing to bad digestion, and becomes rapidly fatal in animals which consume an enormous amount of food, and do nothing but eat from morning to night. The digestive ferments of unhealthy silk-worms do not suffice to destroy the bacteria of the leaves, nor to neutralize their injurious effects. These bacteria are really the cause of the disease, for if even a minute quantity of the leaves taken from the intestine of diseased silk-worms be given to healthy specimens, they soon die of the same disease. It is, therefore, essentially contagious, and, in order to prevent the diseased silk-worms from contaminating the healthy by soiling the leaves on which the latter are about to feed, as much space should be assigned to them as possible.

FIG. 6.—*Micrococcus bombycis* (Cohn), *Flacherie* microbe (× 500 diam.).

Good seed should also be selected, since it has been ascertained that some lots of seed are more liable to the disease than others. The affection does not indeed begin in the egg, as in pebrine, but the question of heredity comes in. It is clear that, when a silk-worm has been affected by *flacherie* without dying of it, its eggs will have little vitality, and the grubs which issue from them will be predisposed by their feeble constitution to contract the disease.

A PSYCHOLOGICAL STUDY OF FEAR.

BY CHARLES RICHET.

THE study of fear, although it is very interesting, has hardly yet been made in a methodical way. While some ingenious observations concerning it may be found in moral and psychological works, the physiologists and philosophers appear to have neglected this

humble emotion. The instructive work of the Italian, M. Mosso, gives an excellent physiological study of the physical phenomena of fear, but is almost the only treatise that bears on the subject. It is our purpose to look at it from the point of view of general psychology, and of the relations of man with animals; and to inquire into the effects and causes of fear among all beings capable of feeling it.

We have, first, to describe the signs of fear and the physical phenomena that accompany it. With man, the testimony of his own consciousness is sufficient. With him fear may be wholly internal and translated by no apparent sign; but he can also afterward give account of his experiences. With animals the case is different. Their only language is their attitude. Our only resource for discovering the emotions by which they may be stirred is by the exterior signs they may give of them; and then we can only draw our conclusions by analogy. My horse all at once raises his head, droops his ears, shies, and starts on a gallop. There was a white cloth before him, and I conclude that he was afraid of it. Have I any right to draw such a conclusion? To affirm it with certainty in every particular, I would have—to use a vulgar expression—to be in his skin; for what I saw does not rigorously prove that my horse had a feeling identical with the one I am acquainted with from having suffered it myself, and which I call fear. Still, I have every reason for believing that the horse's feeling is of the same kind; for his attitude is the same when it thunders or when he hears a violent detonation, things which provoke fear in man; moreover, various other quadrupeds assume nearly the same attitudes when they are surprised by an unexpected object.

When we come to the lower animals it is extremely difficult to determine the operation of fear among them. When frogs hastily leap into the water and swim for their holes at the passing of any animal along the edge of the marsh, is it fear that has moved them? Very likely, although their physiognomy has not changed—for they have none—and we are not able to pass any judgment with regard to the phenomena of consciousness they may have experienced. We all agree that something has affected them that resembles fear in man.

Fear acts in two ways. At times it paralyzes and makes motionless; at other times it excites and gives extraordinary strength. One person overcome by it remains fastened to the spot, pale and inert; his legs give way, and all his forces fail him. Another person scampers away like a rabbit. Fear gives him wings, and he abandons his unhappy companion, who is not able to move, while he has already put himself out of danger. At the same time special physical phenomena are manifested, which can not be described better than in the language of the poets and the common people. The hair stands out on the head; the body is seized with trembling and with a general shiver, and the teeth chatter so that they can be heard. The hands shake so that they can not grasp anything; the legs give way; a

profuse, cold, clammy perspiration covers the body; the skin feels shivering, and the hair-bulbs over it swell up and harden. A convulsive thrill, with a feeling of cold, runs down the body, from the nape to the toe, coursing along the back at intervals like a cold electric wave. The face grows pale, and the heart beats violently, as if it would burst out of the chest; or else, perhaps, it almost stops, producing a feeling of indescribable distress. The pupils dilate, the eyes open wide, and the features assume a repulsive aspect, which has been well represented by the great painters. The voice sticks in the throat, and the victim of the emotion is speechless. These are the manifestations of fear in one of its highest forms. They are less evident in moderate fear, according as it is moderate; while the most intense degree of emotion produces syncope, or arrest of the movements of the heart.

The syncope is rarely prolonged till death ensues; but well-authenticated cases are on record in which death has resulted immediately, while simple syncope is quite frequent. Most of the physical effects of fear, in fact, the pale face, the general weakness and paralysis, the buzzing in the ears, and the vertigos, are symptoms of syncope; and when they accompany sudden fright they are probably less due directly to the fright itself than to the arrest of the movements of the heart which it provokes. This profound emotion of fear, with its accompaniment of violent external phenomena, is fatal and involuntary, and is a reflex action, provoked by an irresistible force, independent of ourselves.

Besides the physical reflex actions, well known to physiologists and often described, I have defined a class of psychical reflex actions. Ordinary reflex actions, like the contraction and enlargement of the pupil under varying intensities of light, are dependent on the most simple excitations and require no intelligence, comprehension, or mental elaboration. Other reflex actions are of a different character. They are reflex, in that they are involuntary; and conscious, in that we can give a complete account of them; but they are also psychical, in that a considerable degree of intelligence is required for them to occur. Take, for example, the simple instance of the soldier who dodges when he hears a bullet whistling near him. The motion is entirely reflex, for the poor fellow has dodged before he has even thought of the ball that might hit him; but it is also conscious and psychical. A number of analogous actions might be cited; and if we give the subject a little attention we shall find that they play an important part in our everyday life. The conscious moral emotion and the exterior movement accompanying it are caused by a sensible excitation which in itself is nothing, but is transformed by the mind so as to become effective. The whistling of a bullet as a mere noise would not cause one to dodge. It is a noise which, in itself, is quite incapable of provoking such a movement. If, then, the soldier dodges so abruptly, it is be-

cause the whistling of the bullet has a significance to him. He knows, without having thought long about it, that it is death passing by him. And before he has performed any conscious reasoning concerning the effects of a whistling bullet, the association of ideas has worked in his mind and determined his sudden movement.

If, while an athlete was performing his exercises on the trapeze, one of the cords should break, the host of spectators would be overcome by great emotion. Some of the women would turn away sick, and others would scream; and the bravest would shiver and turn pale. These phenomena are certainly involuntary and reflexive; but they could not exist without some intelligent comprehension of what has taken place. The breaking of a cord is not an excitant of reflex actions, and, if there were no man's life in the case, the crowd would not feel them.

The lower animals are not susceptible of having psychical reflex emotions, only simple ones; for they have no knowledge, and no judgment respecting the nature of the exciting cause. Many of man's reflex acts are of similar character, as the flow of tears, the reddening, and the vigorous winking when one gets a speck in his eye. Nearly all the psychical reflex acts have as their starting point an excitation of the senses. Such excitations can not of themselves be competent to provoke an organic reflex movement; but, if they are comprehended by an intelligence, and are accompanied by a notion of the exterior phenomenon, they can then determine a reflex act which is the consequence of that notion.

Thus, fear, as a psychical reflex emotion, results doubly: first, in a phenomenon of consciousness, or the fright felt by the me; and, second, in a series of characteristic reflex motive phenomena. The whole central nervous system is disturbed, and the disturbance is communicated to all the motive and glandular apparatus: to the heart, whose beatings are arrested or accelerated; to the muscles, which vibrate; to the salivary glands, which cease to produce saliva; to the intestines, which contract with force; to the vessels of the pallid face; to the sudoriferous glands; to the dilating pupil; and to the features, which reflect the distress of the consciousness.

M. Brown-Séquard has proved by numerous experiments that the nervous system, when it has been subjected to an exterior stimulation, may be excited or paralyzed. The emotions of fear are likewise either stimulating or paralyzing, or inhibitory. Examples of both kinds of effect are numerous. Thus, when a rabbit is overtaken by a dog, it runs away immediately, the faster the more it is frightened. It will leap over wide ditches, pass through almost impenetrable hedges, and strike against objects it would ordinarily avoid, so much is its course precipitated by fear. If the dog pursues it, it leaps and bounds here and there, frightened out of its wits, but more agile and fleet in consequence of its very terror. Another rabbit, under precisely similar

circumstances of pursuit, instead of fleeing, remains still, for the sight of the dog's ardent eyes has inspired in it a fear of a character that will not permit it to withdraw its gaze. It is nearly paralyzed, and is incapable of running away, and fear, instead of making it run, prevents its running. Thus the same emotion is translated by an inhibition in one case, and by an excitation in another.

Very intense fear is generally inhibitory, or paralyzing in its effect, while a lighter fear works an increase of strength. It is known that anger develops muscular force to an extraordinary intensity. This is still more true of fear. A person who is running in fright will leap over obstacles which he would be wholly incapable of overcoming in his normal condition. Numerous experiments show that the brain exercises an inhibitory action over the reflex movements, and that the more active that organ, the more they are under control. It is the will that exercises this power. Fear, likewise, may be modified and regulated, to a certain extent, by the will ; and this is one of the most curious and mysterious phenomena in the history of the emotion.

We have said that psychical reflex emotions do not depend solely on the exterior excitation that disturbs the organism, but largely upon the elaboration of that excitation by the intelligence. The whistling of the bullet that makes the soldier dodge, the roaring of the lion which makes the dog tremble, the smell of the elephant which terrifies the horse, are in themselves indifferent excitations. They have power over the emotions only when they fall upon an intelligent organism which comprehends, with more or less of knowledge, what they mean. Hence the intensity of the fear does not depend upon the excitation itself, but upon the response of the organism to it. It depends upon our individual excitability, which is variable. Some men are naturally brave, others are naturally timid. Children are generally timid, women not so brave as men, and nervous persons less brave than phlegmatic ones. There are also bold and timid animals.

It is probably wrong to use, in distinguishing between individuals, the terms bravery and timidity. A nervous, timorous, and impressionable person may be extremely brave. He may, besides, be all the more deserving for that ; but his temperament makes it easy to startle him ; and it is hard to find a word to express his exact character. An extremely nervous woman may be capable of performing deeds of extraordinary bravery ; but that does not prevent her suffering from fear. It is necessary, then, to distinguish between the emotion, of which we are not masters, and the acts which it commands. There are two elements in fear : the sensational element, or the emotion provoked in the consciousness ; and the active element, or the series of acts which it induces. But in these acts it is necessary to distinguish between real actions performed by ourselves, and organic, visceral, and involuntary motions. The famous saying attributed to Turenne expresses a profound psychological truth bearing upon this point.

When the battle had begun and the bullets and shot, rattling about him, made him tremble, he remarked to himself: "You are trembling, carcass of mine; you would tremble more if you knew where I was going to take you!"

In fact, the feeling of fear can not be subdued. It is an irresistible emotion that depends upon our organization, and one which all the most logical reasonings can not change. Nothing is more true than the common saying that fear does not reason; and it is remarkable how little efficacy intelligence and its efforts have to arrest its effects. I know a highly intelligent person, with a strong and clear mind, who believes he would be lost if he had to go into a boat. Yet the sea is smooth, the course is short, and the boat stanch. Excellent reasoning, but it does not take hold of him. His emotion is stronger than all the arguments you can invent, however irreproachable they may be, and no matter how fully the poltroon may recognize their force. How many children there are who do not dare to cross in the night the garden where they have played all day, where they know there is no danger, and where they will not lose sight of the lights in the house!

An instance out of my own experience will go to show how fear does not reason. About ten years ago, when I was in Baden, near the Black Forest, I was in the habit of walking alone in the evening till late in the night. The security was absolute, and I knew very well that there was no danger; and, as long as I was in the open field or on the road, I felt nothing that resembled fear. But to go into the forest, where it was so dark that one could hardly see two steps ahead, was another thing. I entered resolutely, and went in for some twenty paces; but, in spite of myself, the deeper I plunged into the darkness the more a fear gained possession of me which was quite incomprehensible. I tried in vain to overcome the unreasonable feeling, and I may have walked on in this way for about a quarter of an hour. But there was nothing pleasant about the walk, and I could not help feeling relieved when I saw the light of the sky through a gap in the trees, and it required a strong effort of the will to keep from pressing toward it. My fear was wholly without cause. I knew it, and yet I felt it as strongly as if it had been rational. Some time after that adventure, I was traveling at night, alone with a guide in whom I had no confidence, in the mountains of Lebanon. The danger there was certainly much greater than around Baden, but I felt no fear.

The only effective means of obtaining the mastery over fear is by habit. It is with the moral emotions as with muscular exercise. To become a good walker one must be trained to it, by accustoming himself to greater and greater efforts every day till he arrives at the full extent of his powers. Habit has such an effect upon fear that nothing that is usual to us can make us afraid. Hence the frequency and ease of what is called professional courage. That kind of courage is

not real courage; it is habit. The sailor on the tempest-driven ship; the doctor, the sister of charity, and the attendant in a pest or cholera hospital; the chemist and physiologist surrounded by infections, explosives, and poisons; the aëronaut; the roofer, and the bull-fighter, do not exhibit the test of bravery. They are not afraid. The presentiment of an unknown danger, which is the foundation of all fear, does not exist for them. Operatives who work in factories of powder or dynamite are sometimes so imprudent and so little afraid of a danger which they are perfectly well acquainted with, but to which they are habituated, that it has become necessary to protect them against themselves, and to take rigorous measures to keep them from smoking and from using fire near the powder. Real courage, as distinguished from professional courage, is the fearless confronting of a danger of which we recognize the importance and which we are not accustomed to.

Nothing is more variable than fear. It depends upon the individuality, or, rather, upon the excitability of each individual. Every one has his peculiar quality of excitability, which depends upon his physiological and moral condition, and is not the same for the different excitations. I believe that every man is more or less susceptible to fright; but that fear is caused among different persons by different motives. One is afraid of poisons, another of boats; one of bridges and mountains, another of snakes; another of darkness or of thunder; and each one can find among the excitations that strike upon his senses the one which will be most apt to provoke in him fear. The excitability of each person is also variable according to the time of day, or to his condition in health or disease. The thoughts do not follow the same course in a person who is hungry and in one who has just dined. A convalescent, debilitated by a protracted nervous affection, would doubtless be more accessible to fear than if he were robust, well, and just rising from the table. Attention and the imagination enormously augment the intensity of the emotion. In fact, for all psychical reflex phenomena the excitement is nothing in itself; the reaction of the organism does all. The visual or auditive image which strikes our senses is nothing, so long as it is not transformed and elaborated by the intelligence in such a way as to become at last a frightful image. A child walking on the road at night sees a white cloth swinging in the air; he immediately imagines it a ghost in pursuit of him, and runs away terrified. His imagination has done it all, and if it had not amplified and immeasurably magnified the real image he would not have been afraid. Perhaps we ought all to be more modest than we have been in the habit of being respecting this matter of bravery, and to acknowledge that to be bold is often simply to lack imagination.

In some cases the imagination is blended with attention. To pay attention to an image is, by the fact itself, to aggrandize it and make

it important, to give it relief, vividness, and force. Suppose one person should warn another that he is going to prick him with a pin at a particular point in the skin. For some minutes that pin-prick will have a menacing presence. All the force of the victim's attention will be borne upon it, though it is really inoffensive, and the thought will finally become almost painful. If the same prick had surprised him without his having had time to think about it and concentrated attention upon the insignificant wound, it would probably have passed off unnoticed. But by virtue of attention it has become a great matter. So we may prepare for something we dread, and the long preparation will contribute to double our fear of it. Thus attention is, as well as imagination, an excitatory force, and may render extremely sensitive to fear persons who, without it, might have been bold to insolence. It is true that attention is voluntary to a certain point. We may, it is said, turn away our thoughts to some other subject. But attention can be commanded only when indifferent matters are in question. Violent imaginings and strong emotions command it and are not commanded by it. Thus, from whatever side we regard the problem, we shall find that fear, whether as a sensation or as a conscious emotion, is dependent on our individual excitability and is quite independent of the will. Yet the will may intervene; but, however powerful we may suppose it to be, it has no effect on our feelings, but only on our acts.

The soldier who hears the bullets whistling around him can not control his emotion, which is legitimate; but, by an effort of the will, he can keep from running away and continue to march on. Perhaps a still stronger effort of the will would be required to arrest the psychical reflex movement of dodging, but that is also possible. The will is, therefore, equivalent to a power of inhibition. The power is variable among different persons, and this variability occasions the different degrees of courage.

We have here, apparently, an antagonism between two contrary forces: on one side is the emotion, which incites to certain acts; on the other side is the will, or inhibitory power, which prevents those acts. It seems that when we are stirred by an emotion it can be best opposed by an inverse emotion. The soldier in battle is sustained against his fear by the honor of the flag, the sense of personal dignity, the presence of his chiefs and comrades, ideas of duty and discipline, fear of chastisement, love of country, the hope of reward, and other strong motives. But the soldier's will and the factors that re-enforce it have no control over his organic movements. Though he can resist the inclination to run away and to dodge, he can not hinder himself from trembling and growing pale, or prevent the violent beatings of his heart and the cold sweat. It would therefore be unjust to reproach a person who has passed through a great danger for having become pallid and quaked. Turenne quaked, and he was not a coward.

There are, then, two kinds of bravery—that of the person who does not suffer from fear, which is easy and of little merit, and the bravery of a person who overcomes his fear. Such a person, in my opinion, is more courageous than any other; but, though I have great respect for him, I should put but little confidence in him, for his heroic effort may be overcome at any time, and virtue, beautiful as it is, is less solid than absence of emotion.

He who is overcome by fear and runs away with all his might is certainly not brave, and is not entitled to any eulogy; but we should be indulgent to him. Who knows whether, with a few words of encouragement or enthusiasm, or by becoming accustomed to danger, he might not have been able to conquer his innate sensibility? Doubtless the bravest also have their moments of failure; even if they have not yet had them, the time may come when, surprised by a violent, sudden, and irresistible emotion, they will not be strong enough to triumph over themselves.

We begin the inquiry into the function of fear in the animal economy with the assertion that none of the natural feelings are for nothing. Whatever theory of the origin of beings we adopt, we are always forced to recognize that everything within us serves some end. Fear shows us where danger lies, creates aversion to that danger, and forces us to flee from it, and is, therefore, a protective instinct. We need to be protected. If we had only our intelligence to inform us of danger, we should be very frequently in peril, and our existence would be greatly abbreviated. Nature seems to have a great distrust of intelligence, and to have given it an insignificant part in our self-protection. Emotion comes in first, and intelligence afterward. Wounds that make blood flow are dangerous to the organism; but, if we had to be convinced of the danger from this source to save ourselves from it, men would long ago have disappeared from the earth. Nature has taken the simpler way of endowing us with such sensitiveness to pain that we avoid being wounded, not because the wound lets the blood flow, but for the more evident reason that it hurts us. So we avoid exposing ourselves to danger, not because it is danger, but because we are afraid.

Of the two elements in fear, the internal emotion, of which the consciousness takes cognizance, and the reflex action, all beings have the reflex element; but the emotion, so far as we can perceive, does not appear to be equally present in all. Apparently, it is more powerful the more intelligence is developed; and inferior, unintelligent beings, feel neither pain nor fear with as much force as man. In passing from the brute to man, fear is transformed and generalized. With the animal it is instinctive, answering to no idea. The hen is afraid of the fox, without knowing that the fox may eat it; the gudgeon of the pike, without thinking of its voracity. The horse shies at the sound of thunder, without knowing that lightning can kill him.

They are afraid without knowing why, perhaps even without knowing that they are afraid, while man, with his highly developed consciousness, has a perfect knowledge of his fear. Both man and the brute have in the same degree love of life, dislike of death, and fear in the face of danger. But the notion in the animal is so vague and indistinct that it hardly exists; it is translated by acts the significance of which escapes the actor himself, while in man the same idea becomes precise, reasoned out, and conscious. What we call the instinct for self-preservation is only one of the forms of fear. A violent and irresistible emotion takes possession of our whole being when we perceive ourselves in the face of death, and is the manifestation of a love of life and dread of death that every man bears within himself. It requires real courage to do violence to this general and deep instinct.

We have, therefore, the following progression: The animal, by a simple reflex movement, reacts to excitations that threaten its life; and this reflex movement is admirably adapted to the necessities of its existence.

Next the reflex movement becomes more and more complicated, into a movement of the whole—with flight, outcry, and tremor.

Then, as the animal becomes more and more intelligent, emotion accompanies the action, till the animal not only responds to the menacing excitations by a movement of flight, but has also a conscious feeling of fear.

Finally, a superior degree of perfection appears in man. Besides the act and the emotion, intelligence is displayed, and the man comprehends why he is afraid.

The study of the reactions of the animal shows to what point all the instinctive movements provoked by fright are exactly conformed to the necessity of living, which Nature imposes upon each of her children. When a danger comes which it is necessary to escape, every animal has two means of deliverance. It can flee precipitately, or it can hide and keep still. I believe that the paralyzing and stupefying action of fear, which is manifested in man as well as in the animal, is a salutary instinct, which is probably transmitted from the animal to man, and which, if it is not useful to man, is evidently quite so to the animal. The reaction of immobility is so complete with some animals as to simulate death. There are various insects which, when they are touched, feign to be dead. Every animal has its special kind of reaction. The butterfly flutters in capricious *détours;* the turtle withdraws into its shell; the bee, surprised by an enemy, stings him; the cuttle-fish empties its ink-bag; the hedgehog rolls himself up into a ball; other animals utter piercing cries. These are all reactions that represent different means of defense.

In studying the causes of fear, it is well to lay aside all rational and reasoned causes. When we know that our life is threatened, our

fear is easily explained as the result of the knowledge. A man who is bound to the mouth of a cannon experiences a very strong fear; but, though legitimate, it is not a natural fear in the zoölogical sense of the word. He is in fear because he knows that his life is in danger; but this is a thought-out fear, reasoned and intelligent. Man's rational fears are the fear of death, the fear of pain, and the dread of disesteem. To the fear of death are ultimately referable all emotions of fear, whether conscious or not. Pain is a motive for dread even when it is not mortal, as, for example, in the case of a patient who is awaiting a surgical operation. A more curious kind of rational fear is the fear of disesteem, which is felt by the orator about to make his address, or the actor of any kind to perform his part before the public. It can be assimilated, I think, to the dread that is felt by the patient about to undergo an operation, but is aggravated by the circumstance that, while the patient has only to be passive, the actor knows that the judgment of his audience will depend on himself. In a milder form, it is timidity, such as is shown by young people still unused to society. We shall not enter into the psychological history of these moral fears, interesting as it might be. Nor shall we dwell upon the terror which is determined by the thought of danger and threatened death, for those feelings do not explain the origin of fear. Only the unthought fears can aid in that research.

There is a peculiar feeling, which does not seem identical with fear, though it is of the same character, which may be described as the vertigo of height. It is brought on by the view of a great depth. There is nothing rational in it, for there is no more danger of falling from a great height than from a slight elevation; and a slight barrier, even too slight to afford any real protection, is often sufficient to remove it. But it serves a protective purpose, in guarding us against the perils of elevated places. It is an excellent example of the psychical reflex affection, embodying all of its conditions of being involuntary, conscious, dependent on the sense of sight, and variable with different persons; and it is easily modifiable by education and habit.

The emotion excited by a sudden, violent noise is analogous to fear. It might be described simply as a rudiment of fear; a physical disturbance, or a visceral emotion, producing a momentary response in the mind. Many persons, for instance, are afraid of the sound of thunder. The noise of the storm tends to heighten the effect; and it is likewise observable in animals which, in tropical countries, show great distress during earthquakes and storms, and are also peculiarly sensitive to strident noises.

A loud noise, even when it is not unexpected, always causes a kind of surprise, which is manifested by winking and a general thrill, with palpitation of the heart. During the exposition of 1878 I watched the movements of parties of visitors who stopped to observe the operation

of a pile-driver which thumped down every two or three minutes upon a post. The bystanders would shut their eyes at every crash of the machine, and I was not any more able than they were to keep from doing so.

Three other conditions favorable to the excitation of fear are those of the unknown, of darkness, and of solitude. The fear of the unknown has been named *misoneism*, *μῖσος, dislike; νέος, new*) ; or, to use a more familiar etymology, *neophobia*. It is best exemplified in children and savages; for in mature man use and reason have, as a rule, intervened to correct the instinctive feeling. An infant is nearly always afraid at the first sight of a strange animal, even though it be not very large, but may soon become accustomed to its presence. To savages also, whose intelligence is of an infantine grade, everything that does not enter into the line of daily objects is the subject of fear, when it is imposing in size and vigorous in movement, or of simple amazement when it is small and appears inoffensive. Higher minds, instead of shunning novelty, seek it eagerly. In the student, curiosity takes the place of neophobia. But that curiosity implies a degree of courage; for every unknown thing supposes a possible danger, and real complete security exists only in the face of objects the innocence of which we have tested. We are thus brought back by a rather tortuous way to what we have already said of habit, exercise, and professional courage.

Animals that are used to see man frequently cease to fear his presence. Domestic animals have no such fear of man as wild animals show. Animals also which have never been hunted show no fear when a person comes among them. The most cowardly animals are those which have been most actively pursued. The character of being wild and easily frightened seems to be one that is transmissible to descendants. Since there is no reason for fear existing when there is nothing threatening, the emotion in animals can be explained only by the fact that for series of generations they have been obliged to sustain themselves by flight against aggressors upon them. Neophobia, therefore, should be met among those animals which have experienced dangers, or whose ancestors have experienced dangers. It does not have to be shown that nearly all animals come under these conditions. The more unknown the unknown, the greater is the fear; and the fear of what are supposed to be supernatural phenomena is, where it exists, extremely great.

The effect of darkness in increasing or creating fear is explained by reference to the unknown as a principal cause of the emotion. Darkness is, in fact, the unknown. Light is the one of all the senses that tells us most clearly what is around us; and when it can not perform its part we are of necessity unquiet and troubled. A man traveling in the open field in the full light of day sees everything around him, and goes on boldly in the knowledge that no enemy can escape his

view. But if he is in a thick forest in the darkness of night, he imagines vaguely and without acknowledging it that the gravest of dangers may be awaiting him a step or two farther on. He may not think of particular dangers, but he is simply suffering from a causeless obscure fear that can not be justified. The darkness prevents him from seeing and distinguishing anything, and the mass of shade around him conceals the unknown, that is, possible danger or something frightful. Children and nervous women, being of a more excitable nature, are more sensitive to this influence than men, who are more able to check their emotions by reasoning. But I believe that no one can withdraw himself completely from it. This fear is also common to animals. All horsemen know that their horses are easily frightened during the night, especially when they are traveling on a road that is new to them.

Another condition, which contributes greatly to augment fear, is solitude. It is an abnormal condition. Man is before everything a social animal, and he can not effectively protect himself unless he is sustained by some of his fellows. Hence that need of society under which a danger shared is confronted cheerfully and resolutely, while a danger to which one is exposed alone is often intolerable. This is the fact aside from the influence of self-respect and false shame, which, however, do not fail to play a part in the matter. We frequently check the manifestations of fear so that no one may witness our cowardice. Perhaps none of us would be brave if we were not seen by anybody. On the word of all men who have encountered real dangers, solitary courage is the hardest and rarest. Fear is augmented in solitude, by the thought that we are not protected by any one. Unless we have extreme confidence in ourselves, the feeling of helplessness under such circumstances becomes insupportable, and this without regard to whether our fear is justified or not. The company of any one, even of an infant or an infirm person, is enough to reassure us. The most manifest sign of solitude is silence. A man must be really brave to resist the triple trial of the unknown, darkness, and solitude with silence. Let a familiar sound—the song of a bird, the striking of a clock, the noise of the sea or the wind, the rolling of a carriage, or a human voice—be heard in this solitude, and what a relief!

If we now look at the symptoms and causes of fear as a whole, we shall be able more clearly to understand the simple law that connects all the facts. All living beings are organized to live, and all their emotions and actions are conformable to this great purpose. Hence we have protective emotions or reflex phenomena, which cause us to flee from danger without intelligence and consciousness having to intervene, of which fear is one.

Man, whose intelligence can reach the causes and the laws of phenomena, knows that he must live, and the love of life is so solidly planted within him, that all that offend life—pain and death—offer

motives for fear. If a person is afraid, it is because the images of pain and death are before him.

Fear is, therefore, on final analysis, a protection against death. But salutary as it is, and inspired by nature, the feeling is one that must be energetically contended against, because it is an emotion of the lower class which it is necessary to try to dominate and make submissive to the moral conditions of our existence. We should try to conquer ourselves, and replace the notions of terror by the higher ideas which will perhaps triumph over fear, of self-forgetfulness, abnegation, duty. These ideas will certainly not be without use; but a more effective means, perhaps, though a more humble one, is to habituate one's self to danger, and look in the face as often as possible, but without bravado and without anxiety, the figure of the death which awaits us all.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

SOME PECULIAR HABITS OF THE CRAY-FISH.

By C. F. HOLDER.

IN hardly any other order of animals do we find such a diversity of habits as among the crustaceans, that include the crabs, lobsters, shrimps, etc. Some are of the sea, others of the land, and others of either; in fact, there seems to be no condition in life they do not share. They are found in the deep sea, and floating on the surface in the Gulf Stream. Some are luminous, others transparent, or have the faculty of changing color. Certain species live in caves, finding their homes in subterranean streams. Others, again, are found in hot springs or in the icy sludge of the Arctic Ocean, while in the south or Antarctic region we have a group that are attached to the wings of birds, thus leading a roving, migratory life. From this hasty glance at the possibilities of "crab-life," we may expect almost anything and not be surprised.

Some weeks ago I left Chicago for a short trip on the Northwestern Railroad up into Northern Illinois. The trains do not make particularly fast time, allowing the tourist an opportunity to obtain a more than casual glance as they move along. In observing the fields and farms in this region, I was struck with one peculiarity not seen in the East. In almost every small valley, especially where there appeared to be a stream, the ground was raised in mounds from eight to twelve inches high, and from six to twelve inches in diameter. Generally they were flat on top, and in almost every case were grassed over the entire surface. A few of these would not have attracted especial attention; but, as we proceeded north, they grew more frequent, and finally patches were seen, several acres in extent, completely covered by the curious mounds. Later on I took occasion to visit one of these

localities, and found the prairie completely covered with them for acres. The majority were along the sides of a sluggish brook that held water scarcely an inch deep, and from here they extended away up the slope, so that the most distant heaps were perhaps two hundred feet away from the stream; and, in some cases observed in other localities, no stream or brook could be found, a low, damp spot being the center from which the mounds seemed to radiate or branch. So vast were the numbers of heaps that I could walk for a long distance by merely stepping from one to another, and not unfrequently they were in such close proximity that walking was difficult: a horse in passing over the field presented a curious appearance, evidently finding it hard work; and a carriage would have been wrenched to pieces or badly strained in a short time. The makers of these mounds or heaps were discovered by digging, and proved to be a genus of the common fresh-water cray-fish; and, though I was familiar with their mound-building habits, their location so far from streams was entirely new, and shows that the little creatures are better adapted to a semi-amphibious life than many of their allies that are considered true water-livers.

In making inquiries and investigations into their habits, I found that they differed from our species of the East in certainly, at times, not requiring water. In other words, they passed a certain portion of the time out of the water, and occasionally they would retreat from it; and when floods came they would leave what would be naturally considered their native element entirely and take to dry land.

In a small river that flows through the prairie north of Freeport, Illinois, I found great numbers of cray-fish close in shore, nearly every stone concealing one or more that were well protected by their almost exact resemblance to the bottom in color. Four or five feet above the level of the water were numerous heaps formed in the black clay mud, and almost every one of these contained a cray-fish that was living in water that must have come from above, as the holes had no connection with the river below. Generally I found the little animal out of water, just within the hole, and upon being alarmed it would drop down. Investigation with a stick would show that there were several inches of muddy water in the bottom. The inmates, having no loop-hole for escape, were quite savage, biting at the intruding stick with their powerful claws, and allowing themselves to be almost lifted from the mound.

It would seem strange to find these animals living in this condition if there were not some rational explanation, and it is evident that too much water is equally as disagreeable to the cray-fish here as, if not more so than, not enough, and the mounds and heaps—above and away from the streams—are in this locality the results of the animals' attempts to obtain a location where they can remain in the water or out in safety. To crawl out upon the open bank of a brook would expose them to

numerous dangers; so, to avoid this, they crawl up the banks and burrow into the saturated mud or soil, and at times penetrating from the stream-bed, the earth or mud thrown out forming the mound, an opening or door is generally left at one side or on top. Water collects in the bottom of this burrow, while the upper portion is entirely free, thus enabling the cray-fish to take to the water or not, as it is inclined. These mounds are probably built when the streams rise, the crustaceans leaving the swift current and taking to the higher ground for better security. To show how a flood or over-supply of water will at certain times alarm these little creatures, a gentleman residing in Freeport, Illinois, informed me that not many months ago they had some very heavy rains, that greatly increased the volume of the little river running through the town. The water gradually rose until numbers of quite large trees were submerged, and the stream was almost twice its ordinary width. Such an unusual occurrence naturally attracted considerable attention, and my informant and a number of others visited the trees several times, and when the river was at the highest they presented a strange appearance from a little distance. Their trunks seemed to have changed color from the water up to the branches, and on closer inspection it was found that they were completely incased with cray-fish which covered every available space, crowding upward by hundreds, clinging to the bark and to each other, in some spots packed one upon another four and five deep; every moment added to the throng, new ones emerging from the water, while those above, urged on, crept out upon the branches, and completely covered them, presenting a novel and interesting sight. The animals in many cases retained their positions for several days, and did not seem to be affected by their stay out of water. The occasion, however, was taken advantage of by the people, who came with buckets and brooms and swept them from the trees by hundreds, storing them up for future use. The cray-fish in certain portions of the Western country is a pest to the agriculturist, and the work of these little creatures often greatly increases the labor and expense of breaking up land, especially after the burrows or mounds have stood for many years, the vegetation that has grown upon them often increasing their size to mammoth proportions, comparatively speaking. Some farmers consider, however, that they enrich the land by keeping it open, and in many other ways, and that land with cray-fish-heaps is worth more to the acre from this cause. To the man who plows his land in the old-fashioned way, as many Germans yet do, the cray-fish is a hindrance and a pest. Not the least remarkable feature of the life of this little creature is the fact of its living so far from open streams. In many cases examined by me, no stream or brook was present, a mere bog being the center of attraction. How they had wandered so far from clear running water was a mystery. Scientifically, the cray-fish belongs to the family *Astacidæ*. About fifteen different

genera are known, nearly half being marine, the rest fresh-water forms. The forms most familiar to us are *Cambarus* and *Astacus*. The latter is common on the Pacific slope and in Europe, while the former is the familiar form of our Eastern rivers and streams, finding their way into the Atlantic Ocean. In many localities their burrowing habits are productive of great damage; this is especially so in the levees of the Mississippi. In some parts of the South they are valued as food, and they can generally be found at Fulton Market, New York, a few people evidently knowing their delicacy in salads, etc. In Europe they have long been used as food, and so great is the demand for them in France that large farms are devoted entirely to their cultivation and breeding, the industry affording a profitable income. A study of the habits of these creatures will well repay the student, as many of them are very curious and interesting. They differ from many of the rest of the ten-footed crustaceans in not passing through the various larval stages that characterize the growth of so many of their allies.

LE PLAY'S STUDIES IN SOCIAL PHENOMENA.

By A. G. WARNER.

WHILE George Eliot was still a writer of essays, she complained that the "psychology of the lower classes" was misunderstood by nearly all who had to do with them, from legislators to novelists. She therefore said approvingly, in reviewing the works of W. H. Riehl, that he was "first of all a pedestrian, and only in the second place a political author." In literature, the work of portraying truly the lower classes has since been prosecuted with zeal by herself and others; but social science still shuns methodic observation.

The number of social facts is so nearly infinite that many have lacked the courage even to begin the work of collecting them. Frédéric Le Play was a man who had the courage.

Not a few of the French economists and students of social science have received their early training in the polytechnic schools of Paris. The lesson which their early education seems usually to have taught them most thoroughly is that of the omnipotence of the human reason; they have too often attempted to reform the world by a dead-lift effort of the intellect. The lesson, however, which Le Play derived from his training in the School of Mines and applied to his work in the study of society was that of the vital importance of observation and analysis. His life in theory-breeding Paris only convinced him that social theorizing was the curse of the French people. In 1824 he came to the metropolis, being then in his eighteenth year, and as during his long life, which lasted till 1882, he watched the kaleidoscopic

history of France, he was more and more confirmed in this opinion. After the fall of Napoleon III, he pointed significantly to the fact that during less than one hundred years France had had ten different forms of government—each one set up and overthrown with bloodshed. Horrified by the carnage of the July Revolution of 1830, Le Play vowed to devote himself to the restoration of "social stability and peace"; and turned a large share of his splendid and effective energy to the study of social problems. A new method was developed, a new school was founded, his followers are still vigorously prosecuting the work along lines which he marked out, and the publications of their societies already number some fifty volumes.

As a mineralogist, Le Play's work was to analyze minerals; as a student of social science, he observed men, and strove to analyze at their very source the influences that shape society. In this work he strove, with all sincerity, to be unbiased by preconceived ideas, and he prepared for and began it merely by practicing what he calls "the art of traveling." In order to complete his studies in the School of Mines, it was necessary for him to make personal observations of some extensive mining district, and, having obtained the means of prolonging his journey beyond the time actually required for mineralogy, he set out, in company with his friend Jean Renaud, for the Harz Mountains and the plains of Saxony. For six months, in 1829, they indulged in an energetic note-taking tramp. But in addition to mineralogy they studied what has been termed "the natural history of German life." Their route was through districts which are part of the territory that Riehl afterward tramped over, and, like the author of "Land und Leute," Le Play recognized the fact that he was studying "history incarnate." The two friends were calculated to be profitable companions, each for the other, because they disagreed almost perfectly as to the interpretation that should be put upon the facts observed. Le Play says that they both became convinced that "the social question" was more complicated than they had at first supposed. But he adds: "I was confirmed in my thought that the solution was to be found in a great measure in the customs of the past. My friend, on the contrary, maintained his belief in the doctrine of 'continual progress,' and, in general, in the importance which in this matter, as in all others, he attached to the spirit of change." Thus we see that Le Play had hardly succeeded in divesting himself of preconceived ideas as completely as he seems to have thought. Though beginning with certain prejudices, and though he collected, before he had pursued his studies far, a most formidable array of theories, yet the paramount need of observation was always his fundamental idea. The methods employed by Le Play and his companion of studying the different facts in which they were interested varied according to circumstances. At times they established stations for study (*les stations d'étude*) near the mines, or factories, or families of laborers, or social

authorities (*autorités sociales*) that they desired to learn of. From here they made excursions into the immediate neighborhood to learn more definitely of the local influences that had to do with with the community they were studying. These were supplemented by geological explorations, by more extended explorations of the whole district, and finally by rapid journeys to entirely different districts and new fields of work. "The art of traveling" was with Le Play indeed an art.

His trip through the Harz Mountains and the surrounding districts was useful to him in two ways: First, his researches as a mineralogist were such as to make him at once prominent in that department and insure his continued usefulness to his government; while, secondly, he had had his liking for social investigation heightened and his ideas regarding the proper method of prosecuting these studies rendered more definite. On his return to Paris he took up his studies at once in the laboratory and in the tenement-houses; and so diligently were his researches subsequently carried on that there is hardly an important section of Europe which he did not finally visit. From Sheffield to the Ural Mountains, and from Norway even across the strait to Tangier, he prosecuted his studies regarding the lives and habits of the peasants and laborers, trying always not only to learn definitely of their environment and industrial life, but trying also to understand their thoughts and their mode of thinking. He considers the family the social unit, and is ever reiterating the idea that as the mineralogist studies the different minerals, or the botanist the different kinds of plants, so the student of social science must examine and analyze the individual families. To obtain systematic and cumulative results he developed a fixed method of observation, and a fixed terminology for recording the facts observed; thus rendering the work, even of different men, definite and comparable. All the facts regarding a given family were to be recorded in a monograph prepared according to an unvarying model. The first sixteen divisions of each monograph are always the same; the facts regarding any family are to be marshaled under these rubrics. Under the head of "General Description" the first five of these are grouped and include—1. Character of the soil, labor, and people; 2. Civil status of the family; 3. Religion and moral habits; 4. Hygiene and healthfulness; 5. Social station of the family. Then, under "Means of Existence," are grouped three of the subdivisions as follows: 6. Property; 7. Subventions; 8. The tasks of the different members of the family. Next, under "Manner of Existence," come—9. Food and meals; 10. House, furniture, and clothing; 11. Recreations. Finally, under the division "History of the Family," we find: 12. Principal phases of its history; 13. Customs and institutions assuring the physical and moral well-being of the family; 14. Budget of receipts for the year; 15. Budget of expenses for the year; 16. Family accounts annexed to the budgets. Beyond the sixteenth divis-

ion we find grouped the "noteworthy facts concerning the community or the family," and here the subdivisions are allowed to vary according to the exigencies of each case.

The mere scrap of a hotel bill found in Falstaff's pocket tells much concerning the character of the "valiant knight"; and when we remember that in these budgets of expenses and receipts which Le Play prepared there is apparently nothing omitted which can throw light on the character and condition of the family, we see how suggestive and useful such a system of social and industrial photography might become in the hands of skillful workmen. All sources of receipts are enumerated, including the house-work of the women, and whatever work may be performed by the children. The production of values in use is reckoned at its estimated worth, but the actual receipts and disbursements of money are kept separate. The classification of the expenses is especially suggestive. The expenses for provisions are classed under seven heads, beginning with cereals and concluding with fermented liquors. Next come the expenses for dwelling and the incidentals of heat and light; then follows the expenditure for clothing; while after this are placed the items of expense for religious purposes, for the instruction of the children, for alms, for recreations and festivals, and for health service. The list of expenses is concluded with the outlays necessitated by the work done, by the interest on debts, by taxes, and by insurance. When, in looking over these systematized account-books, we find that a certain Parisian tailor spends two hundred and ninety-five francs for alcoholic liquors, besides six hundred and eight francs spent in hobnobbing at the cabaret, lost at gaming, etc., we are not surprised to find that he spends nothing for religion, but thirty-four francs for education, twenty francs in charity, and saves nothing whatever. The facts taken together tell us very plainly of his character, and, remembering that Le Play made it a point to study none but typical families, we are brought face to face with some "temperance statistics" of a most suggestive kind. We may also see at a glance the difference in economic condition between the semi-nomadic herdsmen of the Ural Mountains where a family consumes seventy-eight per cent of the products of its own labor and the condition of a watchmaker of Geneva, who, assisted at his trade by his wife, consumes only two per cent of the result of their joint labor without exchanging it for money. With the herdsmen the problem of the distribution of the fruits of labor is unimportant, but with the mechanic it is all-important.

With this patient thoroughness Le Play studied some three hundred families in various parts of Europe; and it was while performing this prodigious work that his methods and theories took shape. In 1855 was published the first edition of his greatest work, "Les Ouvriers Européens." It contained thirty-six (afterward fifty-seven) of the most representative monographs. In January, 1856, the French

Academy conferred upon him the Monthyon prize for statistics, and at the suggestion of the Academy there was founded the Société Internationale des Études Pratiques d'Économie Sociale (International Society for Practical Studies in Social Economy). The first article of the statutes of this society declares that its especial purpose is "to determine by the direct observation of facts the physical and moral condition, in all countries, of those engaged in manual labor, and their relations to each other and to those in other classes." The society is to offer prizes to members or outsiders for the preparation of monographs of special value. Before acceptance all papers or reports are discussed by the society, but the regulations forbid the discussion of any theory not based on observed facts; any one violating this rule may be called to order by the president.

In this organization have gathered all those specially interested in the work of social investigation as planned by Le Play, and from it have radiated the various lines of influence along which the work has been prosecuted. Its founder began in cold blood the writing of a library, and the society has carried forward this work most energetically. They have published already five volumes of monographs, and that the series is not intended to be soon finished is shown by the title, "Les Ouvriers des Deux Mondes" ("The Laborers of Two Worlds"). Another series of publications, "Bulletins des Séances," has reached the eighth volume, and the miscellaneous publications of the individual members are numerous. French consuls, interested in the work, have carried it forward in the remotest parts of the earth. One monograph of the series describes a Chinese peasant community of Ning-po-fou; and the last volume contains an interesting monograph prepared by M. Gauldré-Boileau, the French consul-general at New York, picturing a family of French peasants of Sainte-Irénée, in Lower Canada. As early as 1870 the reports of their discussions contain a consideration of the customs of the Chinese and their emigration to California.

In 1872 Les Unions de la Paix Sociale were founded, an organization intended to be far-reaching and calculated as well for propaganda as for study. Each union is located wherever there may be a group of persons interested in Le Play's theories or methods; local investigations are undertaken, questions pertaining to their work discussed, and through a "correspondent" intimate relations are maintained with the district unions and the central union at Paris. The central union dines monthly, and listens to a synopsis of the month's correspondence. The membership of the organizations has aggregated as many as thirty-five hundred persons. "La Réforme Sociale," a semi-monthly review, serves as organ for both the unions and the Société d'Économie Sociale.*

* In 1885 a disagreement occurred between the leaders, and Demolins, a prominent lecturer, for some time the editor of "La Réforme Sociale," withdrew in company with

Under the patronage of the Abbé de Tourville and others, there have also been developed courses of lectures designed to give instruction to university students or others who may be interested in the "method of observation" and the "art of traveling." Le Play admired greatly the English custom of supplementing university training by a period spent in travel, and hoped, by systematic effort, to develop a similar habit in France. Six courses of lectures in this department have been offered in a single year, which have been attended by about one hundred persons. Some of the students, on completing these courses, have been provided with means to put in practice the precepts taught them, and have gone to other countries to study history, or commerce, or politics.

"The dominant characteristic of my work has been," says Le Play, "the accumulation of innumerable facts, and the incessant gathering together of inductions and conclusions." He tells how, after more than ten years of patient though enthusiastic investigation, he began to wonder how it chanced that in the department of social science he had made none of those discoveries that, in the field of mineralogy, had brought him some renown. Then the thought occurred to him that "in social science there is nothing to invent." And thus the phenomenal Frenchman, who had aspired to be an economist without a theory, proceeded to saddle himself with an assumption as arbitrary as any to which an investigator could well enslave himself. Yet we may notice that acceptance of it need not in any way limit one's activity as a collector of facts, for if there is nothing to invent there must be much to find. But Le Play would not even permit himself to say that he had discovered the truths which he came to believe in, but only that he had refound them. "For," he added, "in social science there is nothing new save what has been forgotten." If only one be an expert quarrier, it matters not whether he supposes himself working at the base of a ruined pyramid or in ledges of living rock. But it is easy to see that, while Le Play was entirely confident that his opinions were the outgrowth of observation, yet in reality his methods of observation were largely shaped by his tenaciously held opinions.

This is still more evident when we come to examine the details of his beliefs and his methods. Wherever he looked he found but two things that are really essential to human happiness: the first is the means of subsistence, the other knowledge of the moral law. Whatever social organization insures these two things to all the members of society, thereby insures to them happiness and peace. The moral law is derived from the nature of man and from the decalogue, which formulates and completes it. He arranges, in parallel columns, "The Decalogue of the Hebrews" and "The Decalogue of the Chinese"

others and began to publish "La Science Sociale," which also claims to follow the method of Le Play.

(gleaned in the latter case from no less than six different writers), to show that they are virtually the same. He denominates it the "Eternal Decalogue," and declares that obedience to it is the first essential of social organization. He enumerates seven essentials to the upbuilding of the social edifice. The first, as stated, is the decalogue, and this, with the second, paternal authority, are the two foundation-stones that must be permanent and inseparable. What he calls the "two cements" are religion and the authority of the state; while the "three materials" are the three forms of land-holding, communal, individual, and tributary.

Surely, Le Play is to be classed with "the social architects," yet he and his followers have always inveighed against "the dogmatists of '89," against the Saint-Simonians, the Fourierites, and all others who believed that they had "discovered" the perfect society while groping amid the shadows of an idealized antiquity, or through the cloudlands of their inner consciousness. The "golden age" in which Le Play believed was not of the past only, nor of the future only, but exists whenever and wherever a people fears God and keeps his commandments. His elaborate specifications regarding "the essential organization" of society claim to be only descriptions of what is always found in a society where peace and happiness obtain. He had labored long and faithfully at the task of social analysis, and, when at length he turned to the work of synthesis, it was his firm conviction that in the three volumes, "L'Organisation du Travail," "L'Organisation de la Famille," and "La Constitution Essentielle de l'Humanité," he did nothing more than bring together the influences which rigidly scientific investigation had proved to be the indispensable sources of man's welfare. Among all the races that enjoy social peace and stability he found the solidarity of the family intact; he found that this form of organization gave the best opportunity for the effective training of the children in the moral law; and he concluded that the chaotic and unsatisfactory condition of the foremost nations of Europe resulted from the breaking down of the almost patriarchal system in which he was learning to believe, from the "infinite morselization" (*morcellement infini*) of interests, from that division of labor which compels the father of a family to be too much of a drudge ever to be a guide, and leaves his children's education to the precarious chances of right management at the hands of various sorts of specialists. He dared to say flatly, for his own country, that her politics and social state were the most unsettled in Europe because her morals were the worst, that her laborers were restless and dissatisfied because they were vicious, because "the system of adultery, instituted with *éclat* at the court of Versailles, had led to the public concubinage which now desolates the Parisian workshops."

A remedy for existing evils, he believed, could not be found by ingenious theorizing, but only by the development and application of

whatever is sound and true in the tradition-wealth of each people. In his thought social organization was an art rather than a science. Though many of the legislative remedies he advocated may seem to us peculiarly trivial and inapplicable, yet we must remember that he regarded laws as merely aids to right development, and for the most part sought to ingraft upon existing French legislation only such special features as had been found helpful elsewhere. By changing the laws of inheritance, or giving more power to the fathers of families, one can not bring again the reign of primitive simplicity. For, despite Le Play's denial, we are not in all respects "the same that our fathers have been." Even though it were admitted that the moral law change not, yet the means of procuring daily bread do surely change, and that continually, and in some measure "invention" must be used in social science to find the proper way of fitting society to the changed and changing situation.

But, in spite of all defects, two special merits belong to Le Play's work in social science. The first is, that he insisted on studying concrete, not abstract "society"; he employed the statistical method. It has been said, to be sure, that "figures always lie"; and certainly charts and diagrams, and brace-synopses that profess to set forth social facts, either past or present, should be accepted with profoundest caution. They are things to be used as Spencer uses them in his "Descriptive Sociology," not as being in themselves final results, but only as a means that may help us in reaching results more nearly final. Social facts are too intangible to make it possible to bottle and label them, once for all, as one may chemicals. The per cent "lost in analysis" is always too large to allow the results to be taken as final. But, after all this has been acknowledged, there remain manifest advantages from even "approximate determinations." Though the methods are not perfect, they are the best that social science has, the only ones that make continuous progress possible. The great mass of work done or inspired by Le Play has already been of use to many students not of his school. Laspeyres has classified and compared his "budgets" with valuable results, and the omnivorous German statisticians have, of course, made use of them.

But, aside from right method and patient accumulation of social data, Le Play should, in the second place, be remembered as one who dared to question the seductive finalities of what claims to be economic orthodoxy; who, in turning from the study of abstractions to the study of men, "refound" the need of insisting always upon not only the social and sociologic, but also upon the economic importance of morality and regard for fellow-man.

UNIVERSAL TIME.*

By W. H. M. CHRISTIE, F. R. S.,
ASTRONOMER ROYAL.

CONSIDERING the natural conservatism of mankind in the matter of time-reckoning, it may seem rather a bold thing to propose such a radical change as is involved in the title of my discourse. But, in the course of the hour allotted to me this evening, I hope to bring forward some arguments which may serve to show that the proposal is not by any means so revolutionary as might be imagined at the first blush.

A great change in the habits of the civilized world has taken place since the old days when the most rapid means of conveyance from place to place was the stage-coach, and minutes were of little importance. Each town or village then naturally kept its own time, which was regulated by the position of the sun in the sky. Sufficient accuracy for the ordinary purposes of village life could be obtained by means of the rather rude sun-dials which are still to be seen on country churches, and which served to keep the village clock in tolerable agreement with the sun. So long as the members of a community can be considered as stationary, the sun would naturally regulate, though in a rather imperfect way, the hours of labor and of sleep and the times for meals, which constitute the most important epochs in village life. But the sun does not really hold a very despotic sway over ordinary life, and his own movements are characterized by sundry irregularities to which a well-ordered clock refuses to conform.

Without entering into detailed explanation of the so-called "equation of time," it will be sufficient here to state that, through the varying velocity of the earth in her orbit, and the inclination of that orbit to the ecliptic, the time of apparent noon as indicated by the sun is at certain times of the year fast and at other times slow, as compared with twelve o'clock, or noon by the clock. [The clock is supposed to be an ideally perfect clock going uniformly throughout the year, the uniformity of its rate being tested by reference to the fixed stars.] In other words, the solar day, or the interval from one noon to the next by the sun, is at certain seasons of the year shorter than the average, and at others longer, and thus it comes about that, by the accumulation of this error of going, the sun is at the beginning of November more than sixteen minutes fast, and by the middle of February fourteen and a half minutes slow, having lost thirty-one minutes, or more than half an hour, in the interval. In passing, it may be mentioned as a result of this that the afternoons in November are about half an hour shorter than the mornings, while in February the mornings are

* Address delivered at the Royal Institution of Great Britain, March 19, 1886.

half an hour shorter than the afternoons. In view of the importance attached by some astronomers to the use of exact local time in civil life, it would be interesting to know how many villagers have remarked this circumstance.

It is essential to bear these facts in mind when we have to consider the extent to which local time regulates the affairs of life, and the degree of sensitiveness of a community to a deviation of half an hour or more in the standard reckoning of time. My own experience is that in districts which are not within the influence of railways the clocks of neighboring villages commonly differ by half an hour or more. The degree of exactitude in the measurement of local time in such cases may be inferred from the circumstance that a minute-hand is usually considered unnecessary. I have also found that in rural districts on the Continent arbitrary alterations of half an hour fast or slow are accepted not only without protest but with absolute indifference.

Even in this country, where more importance is attached to accurate time, I have found it a common practice in outlying parts of Wales (where Greenwich time is about twenty minutes *fast* by local time) to keep the clock half an hour fast by railway—i. e., Greenwich—time, or about fifty minutes fast by local time. And the farmers appeared to find no difficulty in adapting their hours of labor and times of meals to a clock which at certain times of the year differed more than an hour from the sun.

There is a further irregularity about the sun's movements which makes him a very unsafe guide in any but tropical countries. He is given to indulging in a much larger amount of sleep in winter than is desirable for human beings who have to work for their living and can not hibernate as some of the lower animals do. To make up for this he rises at an inconveniently early hour in summer and does not retire to rest till very late at night. Thus it would seem that a clock of steady habits would be better suited to the genius of mankind.

Persons whose employment requires daylight must necessarily modify their hours of labor according to the season of the year, while those who can work by artificial light are practically independent of the vagaries of the sun. Those who work in collieries, factories, or mines, would doubtless be unconscious of a difference of half an hour or more between the clock and the sun, while agriculturists would practically be unaffected by it, as they can not have fixed hours of labor in any case.

Having thus considered the regulating influence of the sun on ordinary life within the limits of a small community, we must now take account of the effect of business intercourse between different communities separated by distances which may range from a few miles to half the circumference of our globe. So long as the means of communication were slow, the motion of the traveler was insignificant

compared with that due to the rotation of the earth, which gives us our measure of time. But it is otherwise now, as I will proceed to explain.

Owing to the rotation of the earth about its axis, the room in which we now are is moving eastward at the rate of about six hundred miles an hour. If we were in an express-train going eastward at a speed of sixty miles an hour (relatively to places on the earth's surface), the velocity of the traveler due to the combined motions would be six hundred and sixty miles an hour, while if the train were going westward it would be only five hundred and forty miles. In other words, if local time be kept at the stations, the apparent time occupied in traveling sixty miles eastward would be fifty-four minutes, while in going sixty miles westward it would be sixty-six minutes. Thus the journey from Paris to Berlin would apparently take an hour and a half longer than the return journey, supposing the speed of the train to be the same in both cases.

In Germany, under the influence of certain astronomers, the system of local time has been developed to the extent of placing posts along the railways to mark out each minute of difference of time from Berlin. Thus there is an alteration of one minute in time-reckoning for every ten miles eastward or westward, and, even with the low rate of speed of German trains, this can hardly be an unimportant quantity for the engine-drivers and guards, who would find that their watches appeared to lose or gain (by the station-clocks) one minute for every ten miles they have traveled east or west. This would seem to be the *reductio ad absurdum* of local time.

In this country the difficulty as to the time-reckoning to be used on railways was readily overcome by the adoption of Greenwich time throughout Great Britain. The railways carried London—i. e., Greenwich—time all over the country, and thus local time was gradually displaced. The public soon found that it was important to have correct railway-time, and that even in the west of England, where local time is about twenty minutes behind Greenwich time, the discordance between the sun and the railway-clock was of no practical consequence. It is true that for some years both the local and the railway times were shown on village clocks by means of two minute-hands, but the complication of a dual system of reckoning time naturally produced inconvenience, and local time was gradually dropped. Similarly in France, Austria, Hungary, Italy, Sweden, etc., uniform time has been carried by the railways throughout each country. It is noteworthy that in Sweden the time of the meridian one hour east of Greenwich has been adopted as the standard, and that local time at the extreme east of Sweden differs from the standard by about thirty-six and a half minutes.

But in countries of great extent in longitude, such as the United States and Russia, the time-question was not so easily settled. It was

in the United States and Canada that the complication of the numerous time-standards then in use on the various railways forced attention to the matter. To Mr. Sandford Fleming, the constructor of the Intercolonial Railway of Canada and engineer-in-chief of the Pacific Railway, belongs the credit of having originated the idea of a universal time to be used all over the world. In 1879 Mr. Fleming set forth his views on time-reckoning in a remarkable paper read before the Canadian Institute. In this he proposed the adoption of a universal day, commencing at Greenwich mean noon or at midnight of a place on the anti-meridian of Greenwich—i. e., in longitude 180° from Greenwich. The universal day thus proposed would coincide with the Greenwich astronomical day instead of with the Greenwich civil day, which is adopted for general use in this country.

The American Metrological Society in the following year issued a report recommending that, as a provisional measure, the railways in the United States and Canada should use only five standard times, four, five, six, seven, and eight hours respectively later than Greenwich, a suggestion originally made in 1875 by Professor Benjamin Peirce. This was proposed as an improvement on the then existing state of affairs, when no fewer than seventy-five different local times were in use on the railroads, many of them not differing more than one or two minutes. But the committee regarded this merely as a step toward unification, and they urged that eventually one common standard should be used as railroad and telegraph time throughout the North American Continent, this national standard being the time of the meridian six hours west of Greenwich, so that North American time would be exactly six hours later than Greenwich time.

Thanks to the exertions of Mr. W. F. Allen, Secretary of the General Railway Time Convention, the first great practical step toward the unification of time was taken by the managers of the American railways on November 18, 1883, when the five time-standards above mentioned were adopted. Mr. Allen stated in October, 1884, that these times were already used on ninety-seven and a half per cent of all the miles of railway lines, and that nearly eighty-five per cent of the total number of towns in the United States of over ten thousand inhabitants had adopted them.

I wish to call particular attention to the breadth of view thus evinced by the managers of the American railways. By adopting a national meridian as the basis of their time-system, they might have rendered impracticable the idea of a universal time to be used by Europe as well as America. But they rose above national jealousies, and decided to have their time-reckoning based on the meridian which was likely to suit the convenience of the greatest number, thus doing their utmost to promote uniformity of time throughout the world by setting an example of the sacrifice of human susceptibilities to general expediency.

Meanwhile, Mr. Sandford Fleming's proposal had been discussed at the Geographical Congress at Venice in 1881, and at a meeting of the Geodetic Association at Rome in 1883. Following on this a special conference was held at Washington in October, 1884, to fix on a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the globe. As the result of the deliberation it was decided to recommend the adoption of the meridian of Greenwich as the zero of longitude, and the Greenwich civil day (commencing at Greenwich midnight and reckoned from 0 to twenty-four hours) as the standard for time-reckoning. In making this selection the delegates were influenced by the consideration that the meridian of Greenwich was already used by an overwhelming majority of sailors of all nations, being adopted for purposes of navigation by the United States, Germany, Austria, Italy, etc. Further, the United States had recently adopted Greenwich as the basis of their time-reckoning, and this circumstance in itself indicated that this was the only meridian on which the Eastern and Western Hemispheres were likely to agree.

The difficulties in the way of an agreement between the two hemispheres may be appreciated by the remarks of the Superintendent of the American Ephemeris on Mr. Sandford Fleming's scheme for universal time (which was subsequently adopted in its essentials at the Washington Conference): "A capital plan for use during the millennium. Too perfect for the present state of humanity. See no more reason for considering Europe in the matter than for considering the inhabitants of the planet Mars. No; we don't care for other nations, can't help them, and they can't help us."*

As a means of introducing universal time, it has been proposed by Mr. Sandford Fleming, Mr. W. F. Allen, and others, that standard times, based on meridians differing by an exact number of hours from Greenwich, should be used all over the world. In some cases it may be that a meridian differing by an exact number of half-hours from Greenwich would be more suitable for a country like Ireland, Switzerland, Greece, or New Zealand, through the middle of which such a meridian would pass, while one of the hourly meridians would lie altogether outside of it.

The scheme of hourly meridians, though valuable as a step toward uniform time, can only be considered a provisional arrangement, and, though it may work well in countries like England, France, Italy, Austria, Hungary, Sweden, etc., which do not extend over more than one hour of longitude, in the case of such an extensive territory as the United States difficulties arise in the transition from one hour-section to the next which are only less annoying than those formerly experienced, because the number of transitions has been reduced from seventy-five to five, and the change of time has been made so large

* "Proceedings of the Canadian Institute," Toronto, No. 143, July, 1885.

that there is less risk of its being overlooked. The natural inference from this is that one time-reckoning should be used throughout the whole country, and thus we are led to look forward to the adoption in the near future of a national standard time, six hours slow by Greenwich, for railways and telegraphs throughout North America.

We may then naturally expect that by the same process which we have witnessed in England, France, Italy, Sweden, and other countries, railway-time will eventually regulate all the affairs of ordinary life. There may of course be legal difficulties arising from the change of time-reckoning, and probably in the first instance local time would be held to be the legal time unless otherwise specified.

It seems certain that when a single standard of time has been adopted by the railways throughout such a large tract of country as North America, where we have a difference of local times exceeding five hours, the transition to universal time will be but a small step.

But it is when we come to consider the influence of telegraphs on business life, an influence which is constantly exercised, and which is year by year increasing, that the necessity for a universal or world time becomes even more apparent. As far as railways are concerned, each country has its own system, which is to a certain extent complete in itself, though even in the case of railways the rapidly increasing intercommunication between different countries makes the transition in time-reckoning on crossing the frontier more and more inconvenient. Telegraphs, however, take no account of the time kept in the countries through which they pass, and the question, as far as they are concerned, resolves itself into the selection of that system of time-reckoning which will give least trouble to those who use them.

For the time which is thus proposed for eventual adoption throughout the world, various names have been suggested. But whether we call it Universal, Cosmic, Terrestrial, or, what seems to me best of all, World Time, I think we may look forward to its adoption for many purposes of life in the near future.

The question, however, arises as to the starting-point for the universal or world day. Assuming that, as decided by the great majority of the delegates at Washington, it is to be based on the meridian of Greenwich, it has still to be settled whether the world day is to begin at midnight or noon of that meridian. The astronomers at Rome decided, by a majority of twenty-two to eight, in favor of the day commencing at Greenwich noon, that is, of making the day throughout Europe begin about midday. However natural it might be for a body of astronomers to propose that their own peculiar and rather inconvenient time-reckoning should be imposed on the general public, it seems safe to predict that a world day which *commenced* in the middle of their busiest hours would not be accepted by business men. In fact, the idea on which this proposal was founded was that universal

time would be used solely for the internal administration of railways and telegraphs, and that accurate local time must be rigidly adhered to for all other purposes. It was conceded, however, that persons who traveled frequently might with advantage use universal time during railway-journeys. This attempt to separate the traveling from the stationary public seems to be one that is not likely to meet with success, even temporarily, and it is clear that in the future we may expect the latter class to be completely absorbed in the former. Another argument that influenced the meeting at Rome was the supposed use of the astronomical day by sailors. Now, it appears that sailors never did use the astronomical day, which begins at the noon *following* the civil midnight of that date, but the nautical day which begins at the noon *preceding*, i. e., twenty-four hours before the astronomical day of the same date, ending when the latter begins. And the nautical day itself has long been given up by English and American sailors, who now use a sort of mongrel time-reckoning, employing civil time in the log-book and for ordinary purposes, while, in working up the observations on which the safe navigation of the ship depends, they are obliged to change civil into astronomical reckoning, altering the date where necessary, and interpreting their A. M. and P. M. by the light of nature. It says something for the common sense of our sailors that they are able to carry out every day without mistake this operation, which is considered so troublesome by some astronomers.

In this connection I may mention that the Board of Visitors of Greenwich Observatory have almost unanimously recommended that, in accordance with the resolution of the Washington Conference, the day in the English "Nautical Almanac" should be arranged from the year 1891 (the earliest practicable date) to begin at Greenwich midnight (so as to agree with civil reckoning, and remove this source of confusion for sailors), and that a committee appointed by them have drawn up the details of the changes necessary to give effect to this resolution without causing inconvenience to the mercantile marine.

The advantage of making the world day coincide with the Greenwich civil day is that the change of date at the commencement of a new day falls in the hours of the night throughout Europe, Africa, and Asia, and that it does not occur in the ordinary office-hours (10 A. M. to 4 P. M.) in any important country except New Zealand. In the United States and Canada the change of date would occur after four in the evening, and in Australia before ten in the morning. This arrangement would thus reduce the inconvenience to a minimum, as the part of the world in which the change of date would occur about the middle of the local day is almost entirely water, while on the opposite side we have the most populous continents.

The question for the future seems to be whether it will be found more troublesome to change the hours for labor, sleep, and meals once

for all in any particular place, or to be continually changing them in communications from place to place, whether by railway, telegraph, or telephone. When universal or world time is used for railways and telegraphs, it seems not unlikely that the public may find it more convenient to adopt it for all purposes. A business man who daily travels by rail, and constantly receives telegrams from all parts of the world, dated in universal time, would probably find it easier to learn once for all that local noon is represented by 17 hours U. T. and midnight by 5 hours (as would be the case in the Eastern States of North America), and that his office-hours are 15 hours to 21 hours U. T., than to be continually translating the universal time used for his telegrams into local time.

If this change were to come about, the terms noon and midnight would still preserve their present meaning with reference to local time, and the position of the sun in the sky, but they would cease to be inseparably associated with twelve o'clock.

The introduction of universal time would practically involve the adoption of the system of counting the hours in one series from 0 to 24, instead of in the two series 0 to 12 A. M. and P. M., for, as applied to universal time, the terms *ante-meridiem* and *post-meridiem* would be meaningless, except for places on the meridian of Greenwich. The use of the 24-hour system on railways and telegraphs would naturally assist in breaking the spell of habit which associates noon and midnight with twelve o'clock.

It may be mentioned that the Eastern and Eastern Extension Telegraph Companies already use the 24-hour system throughout their extensive lines of telegraph to avoid mistakes of A. M. and P. M., and to save telegraphing these unnecessary letters. In this connection the President of the Western Union Telegraph Company in the United States has stated that the adoption of the 24-hour mode of reckoning would, besides materially reducing the risk of error, save at least 150,000,000 letters annually on the lines of his company. It is also noteworthy that ninety-eight per cent of the railway managers in the United States, representing 60,000 miles of railway, have expressed themselves in favor of the adoption of the simple notation from 0 to 24 hours.

Considering that the only change which we are called on, in accordance with the Washington resolution, to make in our time-reckoning on railways is the adoption of the 24-hour system, it may be hoped that our railway companies will not be behind those of the United States in appreciating the simplification in railway time-tables which would result from this reform.

A BALD AND TOOTHLESS FUTURE.

By VIRGIL G. EATON.

TO a person who has a moderately well-supplied pocket-book and a thoughtful turn of mind, there can be no more fruitful theme for meditation than to go into our large halls, theatres, churches, and other places of public resort, and, securing a seat in the gallery or in the rear part of the room, look at the heads of the audience, for no other purpose than to ascertain by actual count how many show signs of baldness. Unless the experimenter has been in the habit of counting for this object, he will be surprised to learn that, in most of the Eastern cities, fully thirty per cent of the men over thirty years of age show unmistakable signs of baldness, while nearly twenty per cent have spots on their heads that are not only bald, but actually polished with the gloss that is supposed to belong to extreme old age alone. I have been in the majority of the churches and theatres in all the large Eastern cities, as well as in Chicago, St. Louis, and other places of the West, and have verified my assertion by actual count. From my observation I find that bald-headed men are most plentiful in New York and Boston. After these come Philadelphia, Washington, and the Western towns. I say "men," for two reasons: 1. Because women usually wear their hats or bonnets on such occasions, thus covering their crowns. 2. In case their hats are removed, the hair is combed up so as to cover any possible bald spot, or else there is an artificial "switch" to hide the defects of nature. So, without indulging in any speculations regarding what may be, I will confine myself to what is to be seen.

Here are a few observations taken in Boston. Trinity Church: 243 men; 71 actually bald, 46 indications of baldness. King's Chapel: 86 men; 38 actually bald, 14 indications of baldness. Hollis Street Theatre, orchestra at performance of the "Mikado": 63 men; 27 actually bald, 10 indications. Boston Theatre—Judic: 126 men; 51 actually bald, 43 indications.

These observations were taken from the more cultivated classes of society, and do not give a fair representation of the Boston head, as repeated calls at the dime museums and cheaper variety performances demonstrated. For instance, of the thirty men seen in the seats of the World's Museum in Washington Street, but eight were bald, while only five others had thin hair, showing that baldness was simply a question of a very few years. Again, of forty men at Austin and Stone's Museum, twenty-two had their heads well covered; and at the Windsor Theatre (variety) I found less than twenty-five per cent who had thin hair.

On the other hand, at shows and entertainments of more refine-

ment, the bald-headed element was considerably larger. Of two nights when Patti sang at the Boston Theatre there were forty-six per cent of bald heads on one occasion and forty-two on the other. When De Lussan appeared in "Fra Diavolo" I discovered thirty-eight per cent of baldness, and at one of Matthew Arnold's lectures there were forty-six per cent. In fact, out of hundreds of observations, extending over several years, I have found that the higher the price of admission, and presumably the more refining nature of the performance, the larger the per cent of bald heads. One night I counted the occupants of a few settees in my immediate vicinity at an exhibition which John L. Sullivan gave at the Mechanics' Fair Building, and was surprised to find that less than twelve per cent of the men were bald. As this was a show where the spectators had the privilege of retaining or discarding their hats at pleasure, I think it was not a fair test.

In large cities, where over one half of the population is under thirty years of age, and where half of those who attend places of amusement can safely be placed at less than forty years, these facts are certainly interesting to every person who wishes to know what kind of a looking person the coming man is going to be. It is not uncommon to see men under thirty years of age whose crowns are totally denuded of hair. In one store in New York city are twelve shipping-clerks, all under forty years of age, and seven of them are bald, while two more are vainly trying to prevent baldness by using hair-restorers. There are more bald-headed men in Boston than there are who have black or red hair. Next to the brown heads, the bald heads have the largest number of representatives. In order to prove this, it is only necessary to go to any party or place of amusement or assemblage of any kind in New England. In my capacity as newspaper reporter I attended a funeral in Beacon Street, Boston, a few years ago, where the clergyman, the undertaker, and every one of the mourners were bald-headed! The only perfect head of hair I saw at the house was that of the fair young girl who lay in the casket. Instances showing the proneness, not only of Boston and New England, but of the whole country, to become bald, could be given indefinitely, but I think the foregoing will suffice.

Now, in view of these facts, can any one say that the coming man, of New England at least, will not be bald? If not, what is the present generation doing, or what can it do, to hinder such a fate?

The old physiological law of stock-breeding, that "like begets like," applies to men as well as to animals. If men at the age when they marry and begin to raise children are bald-headed, they can expect their children to enjoy the traits of their sires. A father and mother who become bald when young can safely predict a like result for their offspring. There is no reason why bald heads should not yield to the laws of heredity as much as curly heads or red heads. Anything else would seem unnatural.

To hinder such a tendency it is only needful to learn its cause, which seems to be no other than wearing tightly fitting head-covering, living in-doors, and the lately developed habit of keeping the hair closely cropped. Among the savage races, who live out-doors most of the time and go bareheaded, baldness is unknown. To these hair is a protection. It grows in rank profusion without care. Something is needed to protect the scalp from sun and wind and rain, and hair grows luxuriantly; when hats and caps were invented they took the place of the natural shield, and the hair, having no longer any function to perform, fell away. The days of its usefulness in the economy of life are past, and, like the tails of the monkeys and the muscles of the ears, it has become rudimentary from disuse. If it is to be restored to its former glory, men must stop making "close crops," and must go bareheaded. That there are fewer bald-headed women than men is due to the fact that ladies do not "shingle" their hair after the manner of the sterner sex. The recent fashion of "banging" and "frizzing" their hair, adopted by ladies of fashion, is a death-blow to their sex having good hair much longer. If it continues, there will be as many bald-headed women as men. Allowing the hair to grow long and exposing the head to the weather with little or no protection are the methods by which a rapidly disappearing beauty of the race can be restored. It is to this neglect of fashionable care that the farmers with "hay-seed in their hair" owe their comparative freedom from baldness. The man or woman who wears a closely fitting cap and works in overheated shops and stores, under the rays of gas and electric lights, can not expect to have good hair. If they want to be "worth scalping" they must go out in the open air and expose their heads so that they will feel the need of scalp-locks. Nature never makes anything for which she has no need, and, when she finds that her works are of no use, she proceeds to eliminate the superfluous article.

The same rule can be applied to the early decay of human teeth, and with the same results. Old men now living tell of a time when dentists were almost unknown. The family physician used to keep a pair of forceps and tooth-keys to pull out such teeth as insisted on aching for an unreasonable length of time, while the idea of false teeth was so strange that the person who had a set was an object of curiosity for the whole neighborhood. Now, nearly half the people over twenty years of age have one or both jaws occupied by artificial teeth, and the sign of the dentist occupies a conspicuous place on every street corner.

When the men used to live largely on a meat diet, sometimes cooked, though oftener raw—tearing it off from the bones in great junks, and chewing it like beasts of prey—they had some use for canines and molars, and these implements were furnished to meet the demand. With the invention of knives and forks, of hashes and con-

centrated preparations, of bolted flour, and pies and cakes, came a time when the teeth had few offices to perform, and they began to decay for want of employment. To use a labor-phrase, they were "out of work."

The fact that father and mother have poor teeth descends to the children with even more surety than a deficiency of hair. Dentists inform me that fully one half of their youthful patrons never shed their "milk" molars. They remain in the jaws (or on them) until the possessor is from twenty to thirty years of age, and then decay and come out, or are pulled, to make room for "store" teeth. Owing to this habit, many a person who has a good-looking set of canines and incisors is without a single molar. Wisdom-teeth, that come at full maturity and mark the age of manhood and womanhood, are usually short-lived, and frequently show specks of decay as soon as they appear. Mankind do not use teeth, and so the teeth disappear.

Looking at the facts as presented, there can be but one conclusion regarding the coming man. If the present state of things continues, he will be bald-headed and toothless. From all indications, the time when this kind of a coming man will be here is but a few generations away.

LIFE ON A CORAL ISLAND.*

By Professor W. K. BROOKS.

AFTER the discovery of the Bahama Islands, Columbus writes to Queen Isabella that "this country as far surpasses all other lands in beauty as the day exceeds the night in brilliancy"; and as the scientific expedition of the Johns Hopkins University approached these islands, and the beauties of the land and sea and sky of the tropics began to unfold themselves before our eyes, all the members of our party echoed, in words of their own, the impression of the great explorer.

We had been shut up for nineteen days in a little schooner, smaller than those in which Columbus made his first voyage, in a hold which did not allow us to stand erect, with no floor except a few rough boards laid on the ballast of broken stone. We had found an endless source of pleasure and profit in the examination of the marine animals which drifted by us in the floating sargassum of the Gulf Stream, and we had seen for ourselves what we had so often read, that the ocean is the true home of animal life, and that the life of the land is as noth-

* This interesting sketch of what a party of enthusiastic working naturalists saw outside their laboratory, during a recent visit to the Bermudas, first appeared in the "Baltimore Sun." As it is well worthy a more permanent record than the columns of a daily newspaper can afford, we gladly reprint it from slips kindly sent us by the author. —The Editors.

ing when compared with the boundless wealth of living things in mid-ocean. Still, our three weeks of tossing and pitching in a heavy sea had tried our patience until we were heartily tired of our narrow quarters, and ready to give a warm welcome to any land.

We sighted Abaco, the outermost one of the Bahama Islands, at daybreak on a beautiful Sunday morning, and we were soon in calm water, threading our way before a gentle breeze, which hardly ruffled the surface among the countless small islands which form a fringe or natural breakwater around the "mainland" of Abaco.

This island, which lies nearly north and south, is about a hundred miles long, and its eastern edge is bordered by a narrow sound from three to five miles wide, the outer shore of which is formed by a rim made up of thousands of small islets, or "keys," separated from each other by narrow, winding channels. Some of the keys are ten or twelve miles around, while others are no larger than a small house. They are high and well wooded, with bold headlands and cliffs, and long, winding bays and inlets.

Our first sail among them was an experience which will always remain fresh in our memories. As far as the horizon, before and behind us, was a series of bold promontories, one jetting out beyond another, and, as our vessel rounded one rocky point after the other, new stretches of land and water opened before us with new glimpses of the strange country we had come so far to explore.

We had read many glowing descriptions of the gorgeous beauty of the tropics, but these were all forgotten, and we felt that we were entering a land where everything was new. Our reason refused to put any limit to the wonderful discoveries which filled our imagination, and, as we sailed slowly past cliffs bathed in spray from the breakers which rolled in from the ocean, past the mouths of caves which the sea had hollowed out in the limestone rock, past deep bays and long, winding sounds which penetrated deep into the islands, our fancy peopled every cave and tide-pool with strange animals new to science, and we felt all the glow of enthusiasm which we experienced when we first entered a scientific laboratory and prepared to solve all the problems of the unknown universe.

Navigation among the sunken reefs and submerged islands, which are much more numerous than those above water, is very dangerous. A few miles away the ocean is more than three miles deep, with no land nearer than Africa, and the heavy sea which is always pounding upon the outer reefs soon puts an end to any vessel which deviates from the narrow, winding channels between the ledges of growing coral; but our pilot steered us safely through the crooked inlet between Whale Key and No-Name Key into the inner sound.

Here we saw, for the first time, that intensely green sea which has been so frequently mentioned by voyagers among coral islands. This vivid color soon became more familiar, but never lost its novelty, and

it still holds its place as the most brilliant and characteristic feature of this highly colored landscape, and it is totally unlike anything which is to be seen anywhere except in a coral sea.

The water is so perfectly pure and clear that small objects, like shells and star-fish, are visible on the pure white coral sand at a depth of fifty or sixty feet, and the sunlight, which is reflected from the white bottom, gives to the water a vivid green luster, which is totally unlike anything in our familiar conception of water. The whole surface of the sound seemed to be illuminated by an intense green, phosphorescent light, and it looked more like the surface of a gigantic polished crystal of beryl than water. The sky was perfectly clear and cloudless, and overhead it was of a deep blue color; but near the horizon the blue was so completely eclipsed by the vivid green of the water that the complementary color was brought out, and the blue was changed to a lurid pink as intense as that of a November sunset. The white foam which drifted by the vessel on the green water appeared as red as carmine, and I afterward found in a voyage through the sounds in a white schooner that the sides of the vessel seemed to have a thin coat of rose-colored paint when seen over the rail against the brilliant green.

About noon we reached our destination, Green Turtle, a small town on a key of the same name, nearly a hundred and fifty miles from Nassau, the center of the civilization of the islands. As there is no town between Green Turtle and Nassau, and as the only regular connection in the summer-time between Nassau and the rest of the world is a steamer once a month to New York, and as no message from home could reach us in time for a reply by the same steamer, we were more remote from our friends and families than we should have been in the Sandwich Islands. Although one member of our party had been a traveler in Asia and South America, and all but two had lived in Europe, I think that, as we came to anchor in the little harbor at Green Turtle and looked back upon our long journey, our scanty fare and narrow quarters, and thought of the miles of water which lay between us and home, we all felt that we had never before been so far away. As the strict laws of the island do not permit the transaction of any business on Sunday, we were not allowed to disembark until the next day, and we had plenty of time to examine from the water the new land which we had been so long in reaching.

We came to anchor in the mouth of a beautiful winding bay, in water about thirty feet deep, but so clear that the vessel seemed to float in air, and the motions of the gigantic star-fishes and sea-urchins could be studied on the white bottom as well as if they were in an aquarium. The shores of the bay are high and rocky and well wooded down to the water's edge, where the vegetation ends in a fringe of mangrove-bushes perched above the pure salt water on their long, stilt-like roots, which arch up from the bottom like the ribs of a great

umbrella to meet several feet above the water at the point from which the main stem arises. Behind us, several miles away, is the "mainland" of Abaco, separated from us by the green water of the sound, which stretches in both directions as far as the horizon. In front of us, on the shore of the bay, lies the town of Green Turtle, a much more prosperous and civilized place than we had been led to expect, with freshly painted two-story stone and frame houses, set side by side close to the straight, narrow main street, which is used only as a foot-path, as there are no horses or cattle nearer than Nassau. The main street, which is called Broadway, is hardly more than ten feet wide, while the cross-streets are just wide enough for two persons to pass. They are bordered by stone walls or high fences, and are perfectly level, as clean as the deck of a vessel, pure white, with a bed of solid coral limestone, the inequalities of which are filled with cement.

This description applies to only the better portions of the town, where the white natives and a very few of the negroes live. On one side of the harbor a long, low sand-spit separates this portion from the much more picturesque portion inhabited by the poorer people, most of whom are negroes. Here the little palm-thatched huts, without doors or windows or chimneys, most of them in the most attractive stages of picturesque decay and dilapidation, without any regular arrangement nestle in a thicket of aloe and cactus and bananas and castor-oil plant, which runs parallel to the white sand-beach, and is penetrated here and there by the narrow white foot-paths which lead to the huts.

This is by far the most distinctive and interesting portion of the town, and every feature of the landscape, the clear water, the white beach, the tropical thicket, the thatched huts, the towering cocoanut-trees, and the dark-green leaves of the bananas, are all so thoroughly tropical that, as we lie on the deck of the little schooner floating on the glassy surface of the calm water under the deep blue sky, with great banks of white clouds piled up on the horizon, we have before us every feature which our reading has led us to associate with coral islands, and it is easy to imagine ourselves in the South Pacific.

Our subsequent exploration of the Bahamas showed us that nowhere else in the whole group are so many of the characteristic peculiarities of the tropics crowded into such a small space. We had very scanty information when we made our selection, but the choice of Green Turtle was a fortunate accident, for our first view of the islands gave us a more intimate acquaintance with coral islands than we should have gained in a month spent at Nassau.

Beyond the town the island ends in a bold, overhanging cliff, separated by a narrow inlet from a small, low island, Pelican Key, which is covered by a growth of cocoanut-trees. From our anchorage we can look out through this inlet, framed between the two islands, and

can see the vivid green gradually fading as the water deepens toward the edge of the reef, which is marked by a line of white breakers, heaving and tossing as the swell rolls in from the deep blue water, which stretches beyond until it merges with the lighter blue of the cloudless sky.

Every outline is so sharply defined in the pure atmosphere, and so many elements are crowded into the brilliantly colored picture, that it is more like a landscape traced by fancy in the clouds at sunset than a substantial reality, and the whole is so much like fairy-land that we feel that if we should shut our eyes for a few minutes we should expect on opening them to find the picture dissolving into clouds.

Curbing our fancy, however, and returning to the solid facts about us, science tells us that the history of the country is far stranger than any fairy-story, and that, as the geologist measures time, this whole group of islands, stretching for six hundred miles across the map, and furnishing a home where thousands of people are born and pass their lives, and grow old and die, is actually as transient and unstable as a summer cloud. Only a few years ago, as years go with the geologist, every particle of the land before us was diffused through the ocean in invisible calcareous molecules, which have been gathered from the waves and deposited by microscopic animals, and everywhere about us we find abundant proofs that if these animals should cease their constructive labors the whole would soon be diffused through the ocean like the lump of sugar which is dissolved by our coffee.

After we had familiarized ourselves with this distant view, the custom-house officer came aboard and welcomed us to the islands in the name of the British Government, and told us that, although we could not be permitted to settle on shore until the next day, we were at liberty to land and explore.

All the members of our party will long remember the kind face of this gentleman, Mr. Bethel, with whom we soon became well acquainted. He is not only the custom-house collector, but also resident magistrate, postmaster, health-officer, superintendent of schools, and the general representative of the Government. I myself, as director of the party, was the only witness of the promptness and informality with which he dispatched our business at his office, but we all were made to feel that he is a warm and kindly friend, ready to be called upon at all times for help and advice, and pleased to welcome us at his home.

As soon as we received his permission to land, a party started off in the yawl, which we had brought from Baltimore on the deck of our little schooner, to visit an abandoned house which was pointed out to us upon a hill-side at a distance from the town.

The boat soon reached the mangroves, and, pushing in as far as possible, we found ourselves surrounded by the life of the tropics. As the tide was out, we could reach up from the boat and gather over our

heads the oysters which were growing in great clusters on the roots and branches of the trees. The clear water was filled with fishes of strange forms and brilliant colors, and they were perfectly fearless, so that they could be examined without difficulty, as they chased and captured their food among the submerged roots. The bottom was thickly covered with beautiful sea-anemones, and everywhere, on the bottom, on the roots and branches of the trees, and on the rocks at the water's edge, we found a wealth of mollusks and crustacea, which soon taught us to regard the mangrove-thickets as rich collecting-grounds. We were, however, unable to penetrate through it to the land until we discovered a little cove, where the bushes had been cut down. Pushing the boat into this, we reached an open, grassy landing-place, shaded by two or three cocoanut-trees, and surrounded by a dense forest except at one point, where a narrow path led up the hill to the house.

The front was at first a stronger attraction than the house, and one of the first objects to catch the eye was a great mass of epiphytic orchids on a dead branch close to our landing-place. The species is not one that is prized by orchid cultivators, but the plant, which was much more luxuriant than those which are seen in greenhouses, and in full bloom with flowers which diffused a delightful fragrance through the woods, was gathered just before our return to Baltimore, and was safely carried home, and is now here in full vigor and beauty, a living memento of our first landing on a coral island.

As we were unable to penetrate the thicket without great labor, the party soon made its way along the path up the hill to the old house, which was critically examined as to its fitness for a laboratory and home for our party of seven. It proved to be a one-story frame house, without windows or floor, but out-of-doors the surroundings were all that a naturalist could wish. The exposed side commanded a view of the island and harbor, while the other three sides were surrounded by a dense growth of shade and fruit trees, which had been planted by the absent owner. We also found a large stone cistern shaded by palms and tamarind-trees and orange-bushes, and filled with good water.

We had been informed that there were no vacant houses in the town, and, although this one was very small and not at all suitable for work with the microscope, a residence in this cool and elevated place in the heart of the forest seemed so attractive that the discovery that it swarmed with mosquitoes did not dampen our enthusiasm; and, even after the fine general view of the island, which we obtained from the hill behind it, had shown us that we were separated from the town and from the nearest house by a long, winding sound, and should be compelled to go three or four miles for our supplies, we still felt that the attractions of this retired spot would overbalance all the disadvantages in case no better house could be found in the town.

When the excursionists returned to the schooner, however, they

found that another member of the party, who had also been house-hunting, had found one in the town which was much better fitted for our use. The owner and occupant was willing to vacate and rent to us, but he could not talk business on Sunday. The next morning a satisfactory bargain was made, and after our business at the custom-house had been dispatched we took possession and prepared to land our apparatus and furniture. This work went on slowly, for our house is at some distance from the water, and, as there are no horses or carts, everything was carried up. We found labor very cheap, and, while our nickel cents and five-cent pieces are not regarded as money, a big copper cent is highly appreciated. The pastor of one of the churches kindly exchanged some of our silver money for a pocketful of them from the contribution-box, and a large force of natives was soon hired and set at work. They quickly picked out all the lighter and smaller packages, and a long procession of men and boys and girls was soon on its way to the house, marching like a column of ants along the narrow path from the landing, laden with tin buckets, chairs, nets, oars, and small bundles. The larger boxes required more deliberation, and after one or two journeys most of our assistants resolved themselves into advisory boards and escorts, and a procession was formed for each package, but nothing was lost or stolen or broken, and before night everything was in the house, our beds were set up, and our cooking utensils and provisions were unpacked. The only available stove in the town was rented and set up, a cook was hired, and we were able to rest and to examine our new house while waiting for our first meal on shore.

The house is small, but by using all the rooms as work-rooms, and putting our beds in corners which are of no other use, we have found room for all hands. It is a two-story house, with the walls of stone as far as the second floor, and of wood above, nicely painted and papered, in good repair, with plenty of doors and windows, a large stone cistern of good, cool water, and on the second floor a large veranda overhanging the street in front, for, like all the large houses, it is close to the street, which, as a sign on the corner informs us, is Union Street. It is a narrow pathway about five feet wide, of smooth white limestone.

We are near the corner of Broadway, and on one side of us all the houses are large, well built, and in good repair, with well-kept gardens. On the other side, the street gradually narrows down to an unfenced foot-path, which leads to the brush through a jungle of rank vegetation through which little thatched huts are irregularly scattered. We therefore have all the advantages and comforts of the better portion of the town, but, being on the border-line, we are sufficiently near the more primitive and interesting portion to establish a familar acquaintance with the people, and to get an inside view of their life. This we accomplish the better, as one of the members of our party, who is a

physician, finding that there is no other doctor within a hundred miles, kindly allows the people to call upon him for gratuitous service in his profession. In a few days, as his desire to help those who need him has become known, we are besieged at all hours by patients, who stand in the street and call out, "Is the pill-doctor at home?" He is now so fully employed that his own studies are seriously obstructed, and he has been forced to establish office-hours.

His usefulness is seriously impaired by the fact that a merchant to whom the poor people take their prescriptions to have them forwarded to the apothecary at Nassau is apt to suggest as a substitute a purchase from his stock of strengthening-plasters, or from an invoice of liver-pills which he imported some years ago.

I am surprised to learn from Dr. Mills that in this delightful climate, where the temperature is almost uniform throughout the year, and the thermometer seldom rises above 85° or falls below 80°, there are many cases of consumption. A death from this disease took place in one of the little huts near our house a few hours after our arrival.

We are much pleased that, although our home is close to the street, there is no building opposite, but a vacant lot, planted with cocoanut-trees and bananas, and surrounded by an open cast-iron railing, which does not obstruct our view, or cut off the cool sea-breeze which blows continuously.

Our first day on the island ended in a beautiful cloudless evening, with a gentle breeze and a full moon, and as we sat on our veranda and rested after our hard day's work, the sun set and in a few minutes the moon and stars were in full splendor, for we are so far south that the sun drops straight down, and we have no twilight. As we sat and listened to the mocking-birds, which were singing on all sides, and watched the long, graceful, fern-like plumes of the tall cocoanut-trees swaying against the clear sky in the breeze and reflecting the moonlight from their glossy surfaces, a feeling of perfect rest after our long voyage stole over us, and, while everything reminded us of the long miles of water between us and our friends in Baltimore, we felt almost at home in our new abode.

We watched the half-naked negro children at play in our street, and listened with great interest to wild music which came from one of the huts, and was, as we learned next day, the song of friends gathered at the bedside of our dying neighbor; and at last we ate our first meal of pineapples and bananas and sapodillas and fresh cocoanuts, and then turned in, happy in the thought that we could sleep without holding on, and delighted with our first experience of a coral island.

ARE BLACK AND WHITE COLORS?

By HARRY AUSTIN DOTY.

ALTHOUGH there is no general agreement as to whether black and white are or are not colors, it is very commonly held both by scientists and artists that they are not colors. Encyclopædias, dictionaries, and text-books usually class black and white separately from colors, defining the former as the absence of all color and the latter as the sum of all colors. Von Bezold ("Theory of Color," p. 41) says, "An object appears black if, in the light falling upon it, those species of rays are wanting which alone it is capable of reflecting"; and, again, "White and black . . . which, indeed, are not colors at all in the true sense of the word." But, on page 90 of the same work, the heading of paragraph 48 is "White is a mixed color"; and, again, on page 113 it is stated that "white and all the very pale colors which are closely allied to it must be counted among the cold colors." It is not meant to attach much importance to such little inconsistencies in this very excellent work, but simply to indicate an indecision regarding the limitation of the word color. For another instance may be quoted Field, an English artist, who says of black that the artist is bound to regard it as a color; that "it is colorless, but extinguished light"; that "to be perfect it must be neutral with respect to color and destitute of sheen or reflective power in regard to light," and that "there is no perfectly pure and transparent black pigment." And the same author regards white light as colorless. These latter quotations are not made to emphasize their obvious inaccuracies, but to further illustrate the absence of anything like a unanimity of opinion regarding the classification of black and white in the chromatic scale. Many other opinions might be quoted, showing not only an indecision on the particular point herein discussed, but also widely different ideas concerning the nature of black and white.

In endeavoring to answer the question propounded we can do little more than test the propriety of restricting the application of the word color to less than the entire range of visual impressions. It will be necessary first to inquire just what relation black and white have to other retinal impressions.

At the outset it should be noted that we have no retinal standard. An object may convey a color impression which varies in the same individual with the conditions of rest or fatigue of the eye, with the character of the prevailing illumination, and also according to the influence of neighboring bodies which may produce effects of contrast. There is often a temporary or permanent difference in the color-perception of the two eyes of the same person; and among persons there are of course still wider differences, even excluding abnormal

eyes from the comparison. It is easy to mix a paint which will be called black by one and gray by another, and with a little less illumination the most sensitive eye might detect no gray whatever in the mixture; and even among a number of pigments, all of which would be classed as undoubtedly black, one may by comparison see differences and be able to select some which are "blacker" than the rest. Crumple a piece of white paper, and it exhibits lights and shades of greatly different degrees, some of the shades perhaps being deep enough to be designated black, and all intermediate shades may exist, but any two persons would not be likely to agree upon exactly at what particular shade should be drawn the line between gray and black. The retinal impression, therefore, under ordinary circumstances is not a reliable guide to the classification of the cause which produces it.

Consider, then, how we get impressions of color from objects. The sun emits waves of light varying in length by infinitesimal gradations between the extreme red and the extreme violet of the solar spectrum. As far as our purpose is concerned, we may disregard the ultra-violet and ultra-red rays, which are without perceptible effect upon the retina. These luminous or visible rays, acting together, produce in the eye the impression of white; separately, the longest waves produce red; those a little shorter, orange, and so on to the shortest, which produce violet. Aubert calculated that there were at least one thousand distinguishable primary color-impressions to be obtained from the solar spectrum. These rays of various lengths falling upon the things about us are partly absorbed, partly reflected, the latter portion producing in the eye sensations of color. Nearly all of our color-sensations are produced by this "selective reflection," and it will be unnecessary here to consider the other causes of color-production. Reference will be made, however, to subjective color-impressions further on. Now it is very rare indeed, or never, that but one kind or length of waves is reflected by a pigment or surface; usually several kinds are present, and even surfaces having apparently a pure color not uncommonly reflect rays differing considerably in wave-length from those of the predominant kind. Or, to put it another way, the rays from a surface having a definite hue may find their representatives in the solar spectrum not only in the portion corresponding to that particular hue, but also in one or more remote parts of the spectrum. For instance, the light from green leaves contains not only, in predominance, green rays, but some red rays and some violet rays, which find their representatives in the middle and each end of the spectrum respectively. It is true, further, that almost every hue in nature or art is made up not only of several kinds of rays, but of all kinds found in the spectrum; that is, *some white light is almost always present in that which we receive from illuminated surfaces.*

Now, if blackness were the complete absence of light, the question

as far as it is concerned would be much simplified; but I shall endeavor to show that black is not a negative impression. All black pigments and materials reflect light, and many of them to an extent which makes the fact readily demonstrable. Compare under a bright illumination half a dozen black things to be found in any home—cloths, book-covers, etc.—and it will be seen on a more or less close examination that they are not identical in appearance. Color-makers have their blacks of various intensities and shades. One of the commonest of blacks, lampblack, in comparison with some others, appears a very obvious gray. These black surfaces and pigments can not all be devoid of reflecting power, as they would then be incapable of making any impression upon the retina, and the differences must therefore be due to the various amounts or kinds of light which they reflect. Moreover, *light reflected by black pigments is white light;* that is, they reflect all the different kinds of rays in sunlight. Professor Rood ("Text-Book of Color") found that the black pigments used in his experiments reflected from two to six per cent as much white light as white paper (which, itself, reflects about forty per cent of the light falling upon it), the light being the same in kind and quantity as that from white paper under a sufficiently feeble illumination. There are, it is true, small differences in black pigments in power of reflecting the various components of white light. Blue may be slightly in excess of the normal proportion in white light, and so on, but these are so trifling that they do not affect the question before us. A black pigment with no reflecting power seems to be unknown, and is probably an impossibility. And it is by no means certain that absolute darkness should be taken as a standard of blackness, for several reasons. The impossibility of reaching the standard in practice and of making comparisons in perfect darkness would render it valueless. But the most important objection to it is this: after the retina has ceased to be affected by light, there become manifest certain subjective impressions, perhaps caused by circulation of the blood in the retina, which are not at all suggestive of black;* in fact, a very black pigment appears to the writer much "blacker" than the darkness of a closet. The influence of contrast, which is of course impossible in perfect darkness, seems to be necessary to the impression of the most intense black. An utter absence of retinal excitement would, of course, be no sensation at all, and would be of no more use as a standard of blackness than is the blind spot of the eye, of which we

* With the writer these subjective images often take the form of a circular, or irregular, greenish ring closing in or contracting over a violet background near the center of the apparent field of view, other similar rings succeeding each other in the same way at pretty regular intervals. Although having no bearing upon the subject, it might be added that these images, with others of a similar character, may always be observed in darkness after retiring; and I have a number of times thought I had detected, during the moments between waking and dreaming, a merging of these images, with exaggerations and mental accompaniments, into dreams.

are unconscious until we find by experiment that it is capable of intercepting a retinal image. It seems legitimate, therefore, that black, which, as far as we know it, is but a feeble white, should be classed with other sensations produced by light.

Inasmuch as black is nothing more than white very greatly reduced in intensity, if we can show that white is entitled to rank as a color, evidently black also should be similarly ranked. But with white the case is somewhat different from that of black, in that we have a recognized standard of white light, viz., the sum of the rays in the solar spectrum. These, as already stated, acting in concert upon the retina, produce the impression which we call white. The fact, however, that white light is composite, affords no reason for placing it without the scale of colors, for as far as the sensation produced by it is concerned it is quite as simple as red or green, and no eye is able to analyze it into its components. On the contrary, the sensation of white is brought into close relation with many colors because, like them, it may be produced by various mixtures of less than all kinds of rays. According to Rood, the following pairs of spectrum colors when combined produce a white which is indistinguishable from complete sunlight: red and green-blue, orange and cyanogen-blue, yellow and ultramarine-blue, greenish yellow and violet, green and purple. Groups of three or more kinds of rays may also produce a white, and these white mixtures seem to differ in no essential respect from such other mixtures as yellow and red, which make orange, or red and violet, which make purple. That all of the solar rays produce together white seems to be simply an accident of the retinal constitution; for it is quite conceivable, and consistent with the color theory of Young and Helmholtz, that an eye might be so constituted that the combined effect of the solar rays might be, for instance, blue, while pairs of colors similar to those mentioned might still produce white; and under these circumstances white would probably be called a color and blue would be the standard. Something of this kind does take place under artificial illumination. By gas or oil light, which are both very yellow compared with sunlight, a piece of paper which in sunlight is white would still be looked upon as white, although we know perfectly well that the light it sends to the eye is yellow in hue. The white of daylight appears blue by gaslight. On the other hand, objects which are yellow in daylight we are apt to believe white by gaslight, as they appear of the same hue as white paper seen under the latter light. These illusions are explained by the fact that the prevalent illumination is always regarded as white, no matter what hue it has referred to the standard of sunlight. White paper reflects equally well all the rays falling upon it, and, artificial light having an excess of yellow rays, the paper is really yellow in that light; a yellow object has the property of reflecting principally yellow light, which it exercises in gaslight the same as in sunlight, and

it also is yellow under the former illumination; the white paper and yellow object, therefore, appear of the same hue; but knowing the paper to be white, and through an error of judgment accepting the prevailing illumination as white, the yellow object appears of this color. In view of these facts, it would seem that deductions drawn from the composition of white light are in favor of making it one of the colors. As supporting this view of the matter, might be mentioned Langley's investigations which have shown that the true color of sunlight, before some of its constituents have been filtered out by the atmosphere, is decidedly blue; and that, according to Brücke, ordinary daylight is slightly reddish in tint. It might be claimed as a reason for excluding white from the color series that it has no representative in the solar spectrum, but there is equal reason for excluding purple, unquestionably a color, which has no type in any part of the spectrum, being produced only by a mixture of rays from the red and violet portions of the spectrum. And it has been proved by several observers that all of the spectrum colors when increased in intensity tend toward white, and if made dazzling actually become white. Accepting this fact in a liberal sense, it is plain that white has a representative in every part of the spectrum; and this tendency toward white with increasing illumination being also a property of black, we have a direct argument for the inclusion of the latter with the colors.

In conclusion, it may be urged that the adoption of white and black into the chromatic scale is desirable for the sake of simplicity and uniformity in the nomenclature of this subject.

THE PHILOSOPHY OF DIET.

By a Layman.

IN the years to come it will be debated whether the great minds of the later Victorian era were most concerned with their souls or with their stomachs. Politics we may put by; they are always with us; but politics apart, between these two interests, the spiritual and the peptical, the question of precedence must surely lie. What other claimant can there be? Not literature, thrust away into corners, or tricked out in a newspaper like some May-day mummer; not art, divorced, in Carlyle's phrase, from sense and the reality of things; not music, crushed Tarpeia-wise under foreign gewgaws, or brayed in a chemist's mortar; not the drama, leveled to a tawdry platform for the individual's vanity. Not these, nor any one of these things; but the soul and the stomach, irreligion and indigestion, doubt and dyspepsia—call them what you will—these are the cardinal notes of our great inquiring age.

The former I will not touch. Sir Henry Thompson, indeed, asserts

a wise and orderly method of eating to be a religious duty, and, though the phrase might not quite pass muster in Exeter Hall, in some sense it assuredly is so. In this wise, then, I may profess to be in touch with religion, but in no other. Questions of faith and unfaith (as the fashionable jargon has it) I have neither the ability nor the wish to discuss. It were perhaps no bad thing for the happiness of the future if the wish were as generally wanting to-day as the ability. But on the interior economy of the human frame every man has a right to his opinion. Like faith this, too, it may be said, must take its stand mainly on the evidence of things not seen; but the evidence, at least, in this case, is of a more certain and palpable nature. By what measure and system of nourishment the bodily and mental powers may best be encouraged and preserved, it is every man's duty to discover for himself. If he has any word to say thereon it is, if not his duty, at least his privilege to say it. This is one of the few points of human interest on which every man has a right to say what he thinks, and no man has a right to knock him down for saying it—provided always, of course, that what he says is based strictly on his own experience and limited strictly to his own concerns. In this one instance only, no man has the right to do unto his neighbor as he would do unto himself.

Sir Henry Thompson thinks that our forefathers did not sufficiently consider this great subject. Like Mr. Squeers, they have been, he admits, very particular of our morals. He sees a wise and lofty purpose in the laws they have framed for the regulation of human conduct and the satisfaction of the natural cravings of religious emotions. But those other cravings equally common to human nature, those grosser emotions, cravings of the physical body, they have disregarded. "No doubt," he says, "there has long been some practical acknowledgment, on the part of a few educated persons, of the simple fact that a man's temper, and consequently most of his actions, depend upon such an alternative as whether he habitually digests well or ill; whether the meals which he eats are properly converted into healthy material, suitable for the ceaseless work of building up both muscle and brain; or whether unhealthy products constantly pollute the course of nutritive supply. But the truth of that fact has never been generally admitted to an extent at all comparable with its exceeding importance." Herein were our ancestors unwise. The relation between food and virtue Sir Henry maintains (as did Pythagoras before him) to be a very close relation. His view of this relationship is not the view of Pythagoras, who, as Malvolio knew, bade man not to kill so much as a woodcock lest haply he might dispossess the soul of his grandam. Plutarch also was averse to a too solid diet, for the reason that it does "very much oppress" those who indulge therein, and is apt to leave behind "malignant relics." Sir Henry, in his turn, would not have men to be great eaters of beef, though he holds with Plutarch rather than with Pythagoras, being (so far as I can judge)

no believer in the doctrine of metempsychosis. But on the influence man's diet has on his conduct no less than his constitution he is very sure: "It is certain that an adequate practical recognition of the value of proper food to the individual in maintaining a high standard of health, in prolonging healthy life (the prolongation of unhealthy life being small gain either to the individual or to the community), and thus largely promoting cheerful temper, prevalent good-nature, and improved moral tone, would achieve almost a revolution in the habits of a large part of the community."*

Sir Henry is, perhaps, a little hard upon our forefathers. They thought more on these things, and had a clearer view of them, than he allows. A glance at the voluminous pages of Burton (author of "The Anatomy of Melancholy," not the gentleman who has done his best to spoil the "Arabian Nights" for us); a glance at this book, I say, might have shown Sir Henry how much the ancients thought and wrote—and how wisely too—on the stomachic influence. And always through the years wise men who studied the character and conduct of their kind have commended moderation in gratifying the appetite, and lashed indulgence. Milton, for instance, in a famous passage, has chanted in his solemn music the praises of a sleep which

> "Was aery light from pure digestion bred";

and Pope, in coarser strains, but with equal truth, reminded his fellows

> "On morning wings how active springs the mind
> That leaves the load of yesterday behind!"

A little thought will bring a hundred such passages to the memory.

But their way of thinking was not ours. They spoke generally, and left "the mean, peddling details" alone. "Be not unsatiable in any dainty thing, nor too greedy upon meats, for excess of meats bringeth sickness, and surfeiting will turn into choler. By surfeiting have many perished, but he that taketh heed prolongeth life." That was the text and bearing of their sermons. They did not believe in a written law for regulating these things. Tiberius, says Tacitus, held that man a fool who at the age of thirty years needed another to tell him what was best to eat, drink, and avoid ("*Ridere solebat eos, qui post tricesimum ætatis annum ad cognoscenda corpori suo noxia vel utilia alicujus consilii indigerent*"). It may be remembered, by those who think with Ensign Northerton, that Mr. Sponge (who knew more of Mogg than Tacitus) said pretty much the same thing to Mr. Jogglebury Crowdy, when the latter's unseemly want of that knowledge had helped to spoil a day's hunting. And between Tiberius and Mr. Sponge comes a host of authorities, all harping on the same string. "There is," says Bacon, "a wisdom in this beyond the rules of physic: a man's own observation, what he finds good of, and what he finds hurt of, is the best physic to preserve health." The melancholy

* "Food and Feeding," by Sir Henry Thompson, F. R. C. S., etc., third edition, 1884.

Burton concludes that "our own experience is the best physician; that diet which is most propitious to one is often pernicious to another. Such is the variety of palates, humors, and temperatures, let every man observe and be a law unto himself."

Sir Henry has made elsewhere * some pertinent quotations from a certain Italian work, of some fame in its day, "Discorsi della Vita Sobria," written by Signor Luigi Cornaro. This amiable old gentleman, a native of Padua, addressed himself at the ripe age of eighty-three to give the world assurance how much a sober life could do. He repeated the assurance at ninety-five, and subsequently passed away, "without any agony, sitting in an elbow-chair, being above a hundred years old." An English translation of his Discourse was published in 1768, and from this Sir Henry has made his extracts. But an earlier translation, the work of George Herbert, was published at Cambridge in 1634, in a curious little volume with a very long title, "Hygiasticon, or the Right Course of preserving Life and Health unto Extreme Old Age, together with Soundness and Integrity of the Senses, Judgment, and Memory." This is really the title of the first essay in the book, originally written in Latin by one Leonard Lessius, a divine who has anticipated Sir Henry in the theory of the religious duty. "The consideration of this business," he says, as an excuse for handling such temporal concerns, "is not altogether physical, but in great part appertains to divinity and moral philosophy." Dr. Lessius holds both with Bacon and Burton in their opinion of the value of personal experience, but he treats the doctors somewhat cavalierly. "Many authors," thus his essay opens, "have written largely and very learnedly touching the preservation of health: but they charge men with so many rules, and exact so much observation and caution about the quality and quantity of meats and drinks, about air, sleep, exercise, seasons of the year, purgations, blood-letting and the like, . . . as bring men into a labyrinth of care in the observation, and unto perfect slavery in the endeavoring to perform what they do in this matter enjoin." Bacon does his spiriting rather more delicately: "Physicians are some of them so pleasing and conformable to the humor of the patient, as they press not the true cure of the disease; and some others are so regular in proceeding according to art for the disease, as they respect not sufficiently the condition of the patient."

It is clear that with the wise men of old quantity rather than quality was the ruling law; not what a man ate, but how much he ate was the capital thing for him to consider. A tolerably simple diet is advised, though the wise Lessius holds that the quality of the food matters little, so that the man be healthy; but whatever it be, let there be moderation; measure is the one thing needful. The difficulty of finding this measure is confessed: "Lust knows not," says St. Augustine, "where necessity ends." By the time he had reached his thirty-

* "Diet in Relation to Age and Activity," London, 1886.

sixth year Cornaro had accustomed himself to a daily measure of twelve ounces of food and fourteen of drink—which does not, I own, convey a very exact notion to me, though I take it we Gargantuans should find the measure small. He does not seem to have been particular what he ate, and he did not shun wine. "I chose that wine," he says, "which fitted my stomach and in such measure as easily might be digested." He found it no labor to write immediately after meals. On the contrary, his spirits were then so brisk that he had to sing a song to get rid of his superfluous energies before sitting down to his desk. Lessius is loath to commit himself to any certain scale: "If thou dost usually take so much food at meals as thou art thereby made unfit for the duties and offices belonging to the mind, . . . it is then evident that thou dost exceed the measure which thou oughtest to hold." He tells, on ancient authority, some marvelous tales of the little men have found enough to keep body and soul together: how one throve through a long life on milk alone, how another lived for twenty years on cheese. In monasteries and in the universities this desired measure is, he says, more easily to be found, for there either the statutes of the societies, or the "discreet orders of the superiors" have ordained the quantities of wine and beer that are fit to be drunk. Of monasteries I have no experience, but in the universities I have been given to understand that it is (or was, for the old order changes now so fast that it is hard to say what a day may not bring forth) the custom to leave such matters mainly to the discreetness of the students—which, it may be, is like Goethe's poetry, not always inevitable enough. On the whole, Lessius seems to incline to Cornaro's allowance as sufficient, and perhaps as good an average as it is possible to strike. But he insists, as do all these antique sages, that the measure must vary with the age, condition, and business of the man. No hard and fast rule can there be. The golden mean must vary in all sorts of people, "according to the diversity of complexions in sundry persons, and of youth and strength in the selfsame body." And again: "A greater measure is requisite to him that is occupied in bodily labor and continually exercising the faculties of the body than to him that is altogether in studies." On this point all are agreed; on this and, I am sorry to say, on one other: *qui medice vivit, misere vivit*, "it is a miserable life to live after the physician's forescript."

It will, then, be seen that our forefathers were by no means so negligent of this thing as Sir Henry Thompson fancies. If they were not so minute and curious as we now are, they took at least a broad and liberal view, and surely a most wise one. It is, indeed, his general acceptance of this view which gives Sir Henry's utterances more value than those some of his brethren have put forth. "In matters of diet," run his wise words, "many persons have individual peculiarities; and while certain fixed principles exist as absolutely cardinal in the detail of their application to each man's wants, an infinity of stomach eccen-

tricities is to be reckoned on. The old proverb expresses the fact strongly but truly, 'What is one man's meat is another man's poison.' Yet nothing is more common—and one rarely leaves a social dinner-table without observing it—than to hear some good-natured person recommending to his neighbor, with a confidence rarely found except in alliance with profound ignorance of the matter in hand, some special form of food, or drink, or system of diet, solely because the adviser happens to have found it useful to himself." It is not only the good-natured companion of the dinner-table who errs this way. He were an ungrateful churl who would willingly say a harsh word about our ministers of the interior, so sympathetic, so patient, so courteous, so generous! Yet it must be owned that they are, some of them, a little apt to leave out of sight the varieties of the human constitution, to take all human stomachs as framed on one fixed primordial pattern; above all are they, as old Lessius complained, too likely to "bring men into a labyrinth of care in the observation, and unto perfect slavery in the endeavoring to perform what they do in this matter enjoin." Sometimes I think they do but flatter the weakness of humanity, and when they meet salute each other as the old augurs used. There are folk who will not so much as take a pill at their own venture, and never fulfill an invitation to dinner without a visit to the doctor next morning. He can not afford to drive such inquisitive fools from his door; and so it may be that the healing hand, like the dyer's, becomes subdued to what it works in. The answer given by his physician to Falstaff, on his page's authority, is one it were hardly wise to risk to-day.

I have tried to show that our old forefathers were not so careless of their peptics as has been thought. Yet there was a later time when they were sadly reckless in such matters, and possibly the chronic dyspepsia from which our race seems to suffer to-day may be the heritage of that recklessness. "The fathers have eaten sour grapes, and the children's teeth are set on edge." Certainly our stomachs are more bounded than was Wolsey's. To read the domestic annals of the close of the last and the early years of this century brings back the Homeric tales of the strength and prowess of the heroes who warred on the plains of Troy. No man of these degenerate days could do the work our fathers did, who "gloried and drank deep" like those lusty Jamschyds. They had, to be sure, some few points in their favor that we lack. They did not need—at least they did not use—those intermittent aids to the agreeableness of life that we seem to find so necessary. There were no brandies-and-sodas, no sherries-and-bitters, no five-o'clock teas; they were content with one solid meal in the day, and they did not put that off till it was growing time to begin to think about bed. And, I suspect, the most important point of all, they took life less hastily—not less seriously, but less hastily. Their brains were not always at high pressure; they did not

fritter away their minds and tempers on an infinity of pursuits, pursuits of business and pursuits of pleasure. If they did not all attain Wordsworth's "sweet calm" or the "wide and luminous view" of Goethe, at least they did not insist on barring the way to those blessed goals. This hasty life of ours, these successive shocks of change and alarm, this want of rest and leisure, all act or tend to act injuriously on the stomach, and thence on the brain. It is not only our unwise diet which afflicts the race with those "dolorous pains in the epigastrium," which one very learned lecturer on the philosophy of food asserts to be the note of this age—and which I take to be a glorified form of the homely stomach-ache.

I suspect, too, tobacco may have something to say to it. Not that I would say a word against that "plant divine of rarest virtue" for those who can use it, being indeed myself a feeble unit of the society of "blest tobacco-boys." An ingenious seeker after truth not long ago published the result of his research into the effect of tobacco and strong drink on the studious brain. It was a curious book, extremely amusing, and not all so foolish as might be supposed. But some random utterances there were, and none so random as those of one abstemious student (nameless, if I remember right, but the style was much the later style of Mr. Ruskin) who violently denounced tobacco as a general curse, and refused it all virtues, on the ground that the great men of old did very well without it. "Homer sang his deathless song," so wrote this fearful man; "Raphael painted his glorious Madonnas, Luther preached, Guttenberg printed, Columbus discovered a new world, before tobacco was heard of. No rations of tobacco were served out to the heroes of Thermopylæ; no cigar strung up the nerves of Socrates." Why, truly; and Agamemnon—I speak, of course, under correction of Doctor Schliemann—Agamemnon, I say, knew not the name of Cockle, and Ulysses had never heard of the lively and refreshing invention of the ingenious Mr. Eno; yet who will reason from that old-world ignorance that we might grow wise as Ulysses and brave as Agamemnon if we put away these artificial stimulants? Nay, if it comes to that, have not some fine things too been done since tobacco was introduced? But we need not take this modern counter-blast too seriously. Probably men of sedentary habits who smoke much are very moderate drinkers. He who takes tobacco because he likes the flavor, and finds the use refreshing and soothing, is not likely to take wine or other strong drinks in any quantity. I do not mean that he will not consume them together; that no man capable of appreciating either will ever do. How sad soever be the errors we have fallen into, at least we no longer share Madame Purganti's confusion of mistaking tobacco for a "concomitant of claret." But the virtue of each—I am not thinking of those who use them merely from habit, or because others do, or for a purely sensual pleasure—the virtue of each is, I fancy, a little marred by an adherence to

both. And where the question is not one of virtue, but of sheer fancy or gratification of the appetite, even he who can afford to indulge those delights will be wise to make a choice. At the time I speak of there was not much smoking. Cigars were not much in fashion; the pestilent heresy of the cigarette was not yet dreamed of; the sober pipe was mostly used, generally in that form known as a "long clay," and taken sedately after work was over, as a wholesome aid to reflection. No doubt there were exceptions, men who fuddled themselves over pipes and spirits, or beer; but broadly speaking the use of tobacco then was the exception rather than the rule, certainly among the upper classes of society, and both stomach and brain were thus better able to support the tax laid upon them.

The whole duty of man in this matter lies, as the wise Greeks saw it lay in all matters, in moderation. It is hard to believe that if a man be in a healthy state he need seriously vex his soul on the quantity of starch in his potato, or the relative proportions of hydro-carbons or carbo-hydrates necessary to a perfect diet. If he finds boiled meat more to his taste than roast, white more than brown, if whisky suit him better than brandy, or wine better than either, I can not think it necessary that he should go about very painfully to divorce himself from his liking. And if he finds water most palatable of all beverages, in Pindar's name let him gratify his taste, if he can do so in safety from those numerous and nameless diseases that we are told lurk in the pure element. Let him only be moderate in all things—in water as in the rest, for I take it, to swallow inordinate quantities of water, cold, or after the latest fashion, hot, can be no more wholesome to the human stomach than excessive doses of a stronger drink.

I am thinking of those whose habits must be chiefly sedentary, of those who have to work for their livelihood, to earn it by the perpetual exercise of their brain. And in our time, when once the golden term of youth is passed, these men form by far the most part of the community; men to whom the power of work is life itself—happy are they if it mean only their own life—and who must watch that power as jealously as ever fabled miser watched his gold. What they should eat and drink, and whether they should smoke, sure am I that they, and only they, can decide. Probably they will find that a fixed, unswerving rule is not the best, but that, as Bacon says, "The great precept of health and lasting is that a man do vary and interchange contraries." For myself I find that when living—existing rather, I would say—in London, a stimulating diet is more necessary than when I work in the fresh air and quiet of the country. A moderate amount of wine seems to me needful to balance the impure atmosphere of our great Babylon, to keep body and mind to the mark, jaded as they are by the unending din and bustle of human life. But the fresh breezes, the spacious air, the sunlight, all the beauty and the rest of the coun-

try, fill both body and brain with a strength that needs no artificial spur, and that can be used without tiring. I speak, of course, only for myself; many hard workers, wise workers, think otherwise; to many, very many, life must be lived in London, that wonderful wilderness of crowded humanity, and what it, and it only, can give is a necessity of existence that neither prudence nor fancy may interfere with. There are others, too, who profess themselves to be, and no doubt are, never so well, so attuned for hard work, as when cabined mid the bricks and mortar of London. Here, again, as in the other case, let each man be a law unto himself.

One other word I should like to say on the point of exercise. "You do not take enough exercise" is the common reproach made to the complaining patient; and forthwith off he rushes, to bring into sudden play muscles long disused and limbs that have forgot their cunning, till he finds to his angry astonishment that tired, not refreshed, and aching in every joint and bone, he has but made himself more incapable of work than he was before. No doubt the longer a man can keep up youth's standard of violent delights the better for him; but few men can do that with impunity, still fewer can go back to it when once the touch has been lost; the attempt is generally as dangerous as it is ridiculous. For myself I frankly own that I do not believe that hard exercise of the body is compatible with hard exercise of the brain. Nothing, I am firmly persuaded, brings a man to the end of his tether so soon. The exercise the brain-worker needs is the exercise that rests, not that fatigues. He needs to lull, to soothe his brain; and this he will do best in the fresh air, by quiet, and the gentle employment of the limbs and muscles that have been idle while he worked. It is this need, as it seems to me, that tells most strongly against London. What rest and refreshment is there for him who after a hard spell of work at his desk or in his studio, when

"All things that love the sun are out-of-doors,"

goes out into the noisy, crowded, reeking street? No rest comes to him from any beautiful sight, no rest from any beautiful sound; the air is no fresher than that he has left. Everywhere is a distracting sense of hurry, of the fever and the fret of existence. Like the weary Titan "with labor-dimmed eyes" and ears, alas! not deaf, he goes staggering on to a goal that daily grows more certain and more near. But here, again, I speak only of my own experience, which I would not for the world essay to make the wisdom of others.

In all these things, then, I believe a man must be his best physician. And, beyond the reasons mentioned, he must be so because only he can know what system it is possible for him to follow. Go abroad, says one doctor; get a horse and ride, says another; put your work away and take a thorough holiday, preaches a third. Golden counsel! but, alas, wind-dispersed and vain to so many of us! How

shall those obey it to whom the daily bread comes only with the daily toil, and how many of these there are among it the rich, idle world never dreams!

". . . The fear that kills;
And hope that is unwilling to be fed;
Cold, pain, and labor, and all fleshly ills
And mighty poets in their misery dead."

That is the life's experience of many and many a man who bears a cheerful front enough to his fellows. While he has health and strength, while the sun is still in the heavens, he can bear the burden, uncomplaining if unresting. But as the day wears on, and the shadows grow, the question of the future grows with them, What shall be his fate when hand and brain can work no more? Happy as he may be in his work now, contented, prosperous, never can he wholly put by the thought,

"But there may come another day to me—
Solitude, pain of heart, distress, and poverty."

Such a one can put off that hour by no holiday pastimes which to the idle man of pleasure are a mere weariness of the flesh. But he can, so far as human will avails, put it off by hoarding his strength and health; and this he will most surely do by the observance of one simple rule, framed for man's conduct thousands of years before our wisdom discovered that the pancreatic juice converts starch into sugar, and that levulose is isomeric with glucose—the simple rule of moderation.—*Macmillan's Magazine.*

GERMAN PALEONTOLOGICAL MUSEUMS.

By ALBERT GAUDRY.

THE Germans have many excellent paleontological museums, in which the fossil records of the ancient history of their country are preserved and arranged in regular and proper order. Each of these museums, besides its general character, is distinguished by special features illustrating the more salient peculiarities of the local geology.

Besides its general museum, in which are collected the products of different countries, Stuttgart possesses a geological and paleontological hall devoted especially to the fossils of Würtemberg. This local collection, under the direction of Professor Oscar Fraas, is justly held in high repute, because in it can be followed from age to age the paleontological history of one of those countries in Europe which have been best studied. Here are especially to be seen those wonderful reptiles that lived on the continents during the Triassic epoch: the tosaurus, the zeuglodon, the mastodonsaurus and the metopias, permit

us to form some kind of an idea of the curious appearance of the fauna of that epoch. The Stuttgart Museum is also one of those in which the lias is best represented; and it contains the Holzmaden collection, which is celebrated for its entire skeletons of reptiles. M. Fraas had the kindness a few years ago to conduct me to the locality of the fossils and show me the condition in which they were discovered. They were generally incrusted by the rock, and only bulges were perceptible, which taught nothing to the untrained eye. But my guide was able to divine where the head, the limbs, and the tail could be found, and could even tell me what kind of an animal was concealed in the stone. Those complete skeletons which adorn many museums are brought out by the skillful use of engravers' tools. The Stuttgart collection contains several icthyosauri with their young within their bellies. As a rule, the head is turned toward the anus, as with other vivipares; but I saw one fossil containing two young turned toward the head, and another that had six, turned in as many directions. Is it supposable that the icthyosaurus had sometimes one young one, like the salamander, and sometimes several, like the viper and the slow-worm?

Munich has several important collections under the care of Professor Zittel; that of ammonites, for instance, which is said to be the most complete in existence, and the series of admirable preparations of fossil sponges, the skeletons of which M. Zittel has isolated by steeping them in acidulated water. I was pleased to see there the Pikermi fossils which Wagner first made known. But the principal curiosity of the Paleontological Museum of Munich is the collection of lithographic stones from the oölite of Solenhofen. If we have to go to Stuttgart to study the trias and the lias, it is to Munich we must go to admire the oölite. All geologists are aware that the Solenhofen stones were originally mud deposited on a shore where the inhabitants of the sea and of the continent met. In this mud the most diverse and most delicate beings of the oölite have been preserved with a wonderful perfection. There are to be found in it acalephs, a multitude of crustaceans, insects that have preserved the reticulations of their wings, their feet, and their antennæ, and ammonites with their aptychus, and fishes in course of transition from the ganoid to the teleostean state. Here especially we come to study flying reptiles. They present themselves in all positions. We can see here also the little compsognathus which, long before the discovery of entire iguanodons in Belgium, enabled us to understand the gait of those dinosaurians. The paleontologist might dream, while contemplating this collection of beings, that he could imagine himself in the midst of the secondary period almost as much as if it were still with us; and after seeing it we may readily believe that the day will come when our successors shall have a clear idea of the grand history of past ages.

Vienna, which has long been famous for its life and gayety, has

become a splendid city, with its fortifications replaced by spacious boulevards, adorned with gardens, handsome houses, and palaces. Science is destined to profit largely by these transformations. On one side of the Hôtel de Ville has been built the elegant Parliament-House, and on the other side, as a pendant to it, the Palace of the University. A little way from the Parliament-House, opposite the Imperial Palace, have recently been completed the Museum of Fine Arts and the Museum of Natural History. The University and the Natural History Museum are thus in the finest quarter of the city.

The University building is nearly finished. It is a pleasure to be a student in such a palace. Professor Suess, an eminent *savant* and a member of Parliament, directs the geological collections; and another professor, not less accomplished, Professor Neumayr, the paleontological cabinets. The Museum of Natural History belongs to the court (*Hof Naturalien Museum*). The emperor has just put at its head M. de Hauer, who wasformerly director of the Geological Institute. M. Fuchs is charged especially with the department of paleontology. I was told that the fossils would be separated from living species, as they were in the old museum, and that they would occupy six halls. The Hall of Vertebrates is adorned with mural paintings representing the landscapes of the different geological epochs, with their most characteristic animals and plants. These pictures are separated from one another by statues which have paleontological attributes. One figure holds an icthyosaurus, another the head of a dinotherium, another a part of *Cervus megaceros*, another the head of a *unitatherium*, etc. I only saw a few of the fossils, for they were all disarranged; but, among those which M. Fuchs was able to show me, I remarked skeletons of *Ursus spelæus*, a skeleton of *Megaceros*, and one of the quaternary goat, five specimens of the mastodon and dinotherium, and a series of vertebrates from Maragha in Persia, of the same age as those of Pikermi and those from Baltavar in Hungary which have been described by M. Suess. Besides these collections, I visited by the courtesy of M. Stur, the new director, the *Geologische Reichsanstalt*, which the fossils being arranged according to both the geographical and the geological order, is perhaps the finest collection of stratigraphic paleontology in Europe. Particularly to be admired are the ammonites from the trias of the Austrian Alps, respecting which M. de Mojsisovics has lately made some interesting publications.

I have not been in Pesth lately, but two learned Hungarian professors, MM. de Hautken and Szabo, have assured me that, since I last visited that city, its collections of geology and paleontology have become very important.

In Prague, Professor Fritsch conducted me to the place where the foundations of a grand Bohemian Museum of Natural Sciences have recently been laid. While awaiting the erection of this establishment, a special provisory hall of paleontology has been built near the old

Bohemian Museum, and here Professor Fritsch has collected and arranged in gradation numerous very remarkable fossils. The immense collection of the silurians, made by Barrande, and given by him to Bohemia, has been left in the apartments in the Chotek Gasse in which the eminent geologist resided. It is hardly possible to conceive of its richness in orthoceratites, cyrtoceratites, and trilobites. I saw an example here of the degree to which the love of paleontology may be developed, for in the more than humble rooms, where the eminent tutor of the Comte de Chambord passed most of his life, there are collections of primary fossils that cost enormous sums. Barrande was parsimonious toward himself, lavish to science. His collections are to be removed to the museum now in building. A young Czech professor, M. Novak, and a German geologist, Herr Waegen, distinguished for his works on the paleontology of India, are continuing Barrande's labors on the silurian formation of Bohemia.

Dresden, whose picture-galleries attract artists from all countries, has also greatly improved its galleries of geology and paleontology. Their director, Herr Geinitz, has arranged the fossils in geological order, so as readily to convey an idea of the history of past ages. The creatures of the Permian epoch are particularly well represented. No person has contributed so much as Professor Geinitz to the knowledge of that epoch, which was formerly believed to represent a moment of a slackening of the vital forces, but has furnished during several years past a multitude of fossil plants and animals.

Berlin has an entirely different character from Vienna. If we were living in pagan times, we might say that in Vienna they would raise statues in honor of Apollo, Minerva, and perhaps Venus, but in Berlin of Mars. Vienna is always panting for pleasures, especially the pleasures of the mind. Berlin, isolated in regions that the moraines of the glacial period left devastated, prefers the hard things of military life. But the government is interested in science as well as in military affairs, for it knows that intelligence makes strength. A large building has recently been erected in the Invaliden Street for the geological collections of which M. Hauchcome has charge, and another for the collections of agricultural arts in which M. Nehring has placed the curious quaternary fauna which he has described as the fauna of the steppes. Between these museums a grand Museum of Natural History is to be built. The university has excellent collections in geology in charge of Professor Beyrieh, and in paleontology under the care of Professor Dames. Among them may be seen the second specimen of the archæopteryx, which cost three thousand dollars. It has the advantage over the specimen in the British Museum of possessing a head, and of showing its fore-limbs, the fingers of which are not united as in existing birds. Professor Dames has recently published an interesting memoir on this curious creature.

I might also speak of Russia, where I saw fine collections of fossils

at Dorpat, St. Petersburg, and Moscow; of Brussels, where the little Belgian state has made liberal expenditures for its iguanodons, mososauri, and hainosauri; and of Haarlem, in Holland, where the Jeyler Museum is being enriched every year with new paleontological curiosities; of Switzerland, which is not behind any country in the zeal with which it cultivates science; and of Italy, where science has its share in the revival which all departments of the intellectual life are enjoying. But I have said enough to show that paleontology is cultivated and held in high regard in Continental Europe, and that we Frenchmen also should not be indifferent to the questions of the origin and development of life.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

NITRIFICATION.

By Professor H. P. ARMSBY.

THE production of nitrates during the decay of nitrogenous organic matter under suitable conditions of moisture, aëration, and temperature, is a reaction of no little importance both technically and agriculturally: technically, as the sole natural source of saltpeter; agriculturally, on account of the fact that the nitrates formed in the soil constitute the chief if not the only supply of nitrogen to the plant. But, while the conditions of nitrification have long been well known, it is only within the past eight or nine years that its true cause has been recognized. Pasteur, in 1862, appears to have first pointed out the similarity of nitrification to the various oxidations of organic matter known to be effected by the agency of mycoderms, and of which the acetic fermentation is the typical example.

In 1873, A. Müller* advanced the opinion that nitrification was due to the action of a ferment. He based his opinion the fact upon that solutions of pure ammonium salts and of urea are very stable, while the same bodies in sewage are rapidly nitrified, holding that the difference was due to the presence of a ferment in the latter case. In 1877 Schloesing and Müntz† published the results of experiments which indicated that Pasteur's suggestion and Müller's opinion were correct, and that nitrification might really be classed as a fermentation. These experimenters were engaged in investigating the oxidizing effect of the soil upon sewage. They filled a glass tube one metre long with a mixture of quartz, sand, and a small quantity of powdered limestone, and caused sewage to filter slowly through this artificial soil, so that it occupied eight days in passing through the tube. For twenty days the sewage passed through unaltered. Then nitrates began to appear

* "Landw. Versuchs-Stationen," xvi, p. 273. † "Comptes Rendus," lxxxiv, p. 301.

in it, and rapidly increased in amount until all the nitrogen of the filtrate was in this combination. If nitrification is due to simple oxidation, it is difficult to see why it was so slow in commencing; but, if it is due to an organism which required time to develop in the artificial soil, the delay is at once explained.

Sewage was passed through the soil in this way for four months, with complete oxidation of its nitrogen. As soon, however, as vapor of chloroform, which is known to be inimical to the action of organized ferments, was caused to penetrate the soil, nitrification ceased, and did not recommence after the chloroform was withdrawn. After the sewage had passed unchanged for seven weeks, a small amount of turbid washings of a soil known to nitrify with ease was poured upon the top of the soil. After eight days (i. e., exactly the time required for the liquid to traverse the column of soil), nitrates reappeared in the strata, and continued to be formed as long as the experiment was continued. All these facts point plainly to an organism as the cause of nitrification. It developed in the soil during the first twenty days of the experiment from germs introduced by air or sewage; it was killed by the chloroform-vapor, and reintroduced in the soil-washing.

In 1878 appeared the results of experiments made by Warrington* in the Rothamsted Laboratory, which fully confirmed those of Schloesing and Müntz. He first showed that a very considerable nitrification took place in a good garden-soil when a current of air was aspirated through the moist soil, but that hardly any formation of nitrates took place when this air contained vapors of chloroform or carbon disulphide, while vapor of carbolic acid seemed to produce the same effect so far as it was brought in contact with the soil. Thus far the results were simply confirmatory of those of Schloesing and Müntz. Further experiments, however, developed the important fact that nitrification could be brought about in dilute solutions of ammonium salts, by seeding them with a small amount either of a nitrifying soil or of a similar solution which had undergone nitrification. The first experiments were made with the dilute solutions employed in the determination of ammonia by Messler's method, with the addition of small quantities of tartrate and phosphate of potassium, and precipitated carbonate of calcium. The solutions used in later experiments had the following composition per litre:

Ammonium chloride	80	milligrammes.
Sodium potassium tartrate	80	"
Potassium phosphate	40	"
Magnesium sulphate	20	"

Precipitated calcium carbonate was added to supply the necessary base. By this discovery the way was opened for the easy and fruitful study of the process and of the conditions affecting it.

Since the publication of Warrington's paper, a large amount of

* "Transactions of the Chemical Society," 1878, p. 44.

work has been done in this direction both by this investigator and by others. As a result, the ferment theory of nitrification has been very thoroughly established, the organism producing it has been isolated, and considerable progress made in the study of the conditions affecting nitrification, particularly in fluid media.*

That nitrification is due to the action of a living organism is shown in various ways. Sterilized solutions, otherwise suitable for nitrification, have been preserved for as long as three years unchanged. But, if to such a solution a small amount of a solution or a soil in which nitrification has recently taken place be added, the solution nitrifies within a short time.

Nitrification is strictly confined to the range of temperature within which the action of low organisms is possible. It does not take place unless all the nutritive materials necessary for such organisms are present, absence of phosphoric acid, for example, completely preventing it. Antiseptics, as already illustrated, inhibit nitrification. The action of heat likewise confirms the ferment theory. The temperature of boiling water at once stops nitrification, and it is not resumed until the medium is seeded again from some external source.

Some of the more important conditions affecting nitrification in liquids (and presumably also in porous solids, such as soil) are: 1. Alkalinity of the solution; 2. Concentration of the solution; 3. Character and amount of the ferment; 4. Temperature.

1. While nitrification does not take place in the absence of a salifiable base, any considerable degree of alkalinity greatly retards it, and, if it exceeds the equivalent of about three hundred and fifty parts of nitrogen per million, stops it.

2. Under like circumstances, nitrification begins more promptly the more dilute the solution. No definite limit of concentration can be stated, beyond which nitrification can not take place on account of the great differences caused by differences in the—

3. Character and amount of the ferment. The character of the ferment is determined by its previous history. A strong ferment, producing prompt and rapid nitrification, is obtained by repeated cultivations in moderately strong solutions well supplied with nutritive matter, while the opposite course produces a weak ferment. The stronger the ferment, and the greater the amount of it used for seeding, the sooner the nitrification begins, and the greater is the admissible concentration of the solution.

4. Nitrification has been observed to take place at a mean temperature of 3·2° C. The superior limit seems to be 40° to 50° C., the optimum 35° to 37° C.

A variety of nitrogenous substances have proved susceptible to nitrification in solution. The weight of evidence, however, appears to

* Compare especially Warrington, "Transactions of the Chemical Society," 1884, p. 637.

show that in all cases the nitrogen first assumes the form of ammonia, and that the latter is, strictly speaking, the only substance capable of being nitrified. In the case of urea this has been observed to lead to some interesting results. Thus, if nitrification is induced in a solution of urea containing no salifiable base, the process stops when one half the nitrogen has been oxidized, ammonium nitrate being produced. If the concentration exceeds a certain limit no nitrification occurs, the alkalinity produced when the urea is converted into ammonium carbonate being sufficient to prevent the action of the ferment. If, however, gypsum be present, the well-known double decomposition into calcium carbonate and ammonium sulphate takes place, and, the latter having a neutral reaction, nitrification proceeds unhindered.

An interesting and hitherto unexplained fact which was noticed in Warrington's experiments is, that sometimes nitrous and sometimes nitric acid was produced, and at times both in the same solution. The experiments thus far published suggest the possibility of the existence of two ferments, a nitric and a nitrous, but on this branch of the subject we may expect more light when investigations now in progress at Rothamsted are made public.

Some investigations into the distribution of the nitric ferment in natural soil are summarized by Warrington as follows: "I am disposed to conclude that in our clay soils the nitrifying organism is not uniformly distributed much below nine inches from the surface. On much slighter grounds it may perhaps be assumed that the organism is sparsely distributed down to eighteen inches, or, possibly, somewhat farther. At depths of from two feet to eight feet there is no trustworthy evidence to show that the clay contains the nitrifying organism. It is, however, probable that the organism may occur in the natural channels which penetrate the subsoil at a greater depth than in the solid clay. In the case of sandy soils we may probably assume that the organism will be found at a lower depth than in clays."

SKETCH OF GENERAL JOHN NEWTON.

GENERAL NEWTON has commended himself as one who is entitled to acknowledgment for useful and distinguished service in two fields. As a member of one of the branches of the military establishment he did active duty as an army engineer and a commander of men, acquitting himself with honor on every occasion, during the whole period of the war of the rebellion. In peaceful times, his career has been within his own preferred field of work, where theoretical knowledge and practical skill in application and execution were equally in demand, and were united in carrying out the important enterprises that were intrusted to him. In his works as an engi-

neer, which may be found all along our Atlantic sea-coast, and particularly in the clearing of the channel of Hell-Gate, he has shown himself a man who held the resources of science in his hand, and knew exactly what to do with them; and in the use he made of them, to promote the greatest public benefit, the originality of the devices which he contrived, and the certainty with which he accomplished his designs, he has shown himself to possess the highest title to scientific recognition.

JOHN NEWTON was born in Norfolk, Virginia, August 24, 1823. His father, Thomas Newton, represented the Norfolk district in Congress for thirty years, and was, when he retired, the oldest member in service in the United States House of Representatives. After having been given such instruction as the schools of Norfolk could confer, young Newton, when about twelve years old, was placed under private tuition, especially in mathematics, for which he showed a marked taste, with the purpose, already formed, apparently, of making a civil engineer of him. He entered the Military Academy at West Point in July, 1838, where, we are informed, his worth as a careful and comprehensive student was known and recognized by his superiors, and his natural bent and acquirements were at once given opportunity for play. Upon his graduation from the Academy in 1842, he was appointed a second-lieutenant in the Corps of Engineers. He served as assistant to the Board of Engineers in 1842 and 1843; and in the Academy, first as assistant professor and afterward as principal assistant Professor of Engineering, from 1843 to 1846. In the latter year he was designated as assistant engineer in the construction of Fort Warren, Boston Harbor, and Fort Trumbull, New London, Connecticut. From this work he was transferred to be superintending engineer of construction of Forts Wayne, Michigan, and Porter, Niagara, and Ontario, New York. In 1852 and 1853 he was engaged in superintending the surveys of Cobscook Bay, Kennebec River, and Matinicus Islands; and for the breakwater at Owl's Head, in Maine. Next we find him in Florida on similar work, looking to the improvement of St. John's River, the Haul-over Canal, and the repair of the sea-wall at St. Augustine; in Georgia, looking after Forts Pulaski and Jackson, and the improvement of lighthouses on Savannah River; at Sullivan's Island, attending to the trial and inspection of the dredge-boat for the bar; and again in Florida, supervising the fortifications and lighthouses of Pensacola Harbor, from 1855 to 1858.

He was appointed in 1853 a member of the commission for devising a project for the improvement of St. John's River; in 1856, of the board to examine Pensacola dock; and of the special board of engineers to select sites and prepare projects for the coast-defenses of Alabama, Mississippi, and Texas. There also appears, under the date of July 1, 1856, a record of Lieutenant Newton's appointment as captain of engineers, for fourteen years' continuous service. He was

made chief engineer of the Utah Expedition in 1858, and afterward superintending engineer of the construction of Fort Delaware, and of repairs of Fort Mifflin, Delaware Bay; and of the special board of engineers for modifying the plans of the fort at Sandy Hook, and for selecting sites for additional batteries at Fort Hamilton.

These occupations engaged his attention down to the time of the outbreak of the rebellion in 1861, when he entered the active service as chief engineer of the Department of Pennsylvania, in which capacity he accompanied General Paterson's column in the Valley of Virginia, and was engaged in the action of Falling Waters. He was also, in this year, chief engineer of the Department of the Shenandoah, assistant engineer in the construction of the defenses of Washington, and commander of a brigade in the defense of the capital, till March 10, 1862; and was appointed major of the Corps of Engineers and brigadier-general in the volunteer service. In 1862 General Newton served in the Army of the Potomac in the Peninsular and Maryland campaigns, and was engaged in the actions at West Point, Gaines Mill, and Glendale; in the retreat from the second battle of Bull Run; and in the battles of South Mountain and Antietam. At West Point, when it was found that the Union army was threatened by the interposition of the forces of Gustavus W. Smith, at Barhamsville, with their retreat cut off by the river in their rear, Newton went out at dawn to reconnoitre. He found that marshes covered all their position except a space sufficient for the movements of one brigade. He planted his own brigade there, and with it held the post against attack. At South Mountain General Newton's brigade, attached to General Franklin's corps, was one of the three brigades composing the division of General Slocum, which advanced up the side of the mountain, and repulsed the enemy's force. The same brigade won formal commendation for its behavior at Gaines Mill and at Glendale; and its commander was brevetted lieutenant-colonel (regular army) September 17, 1862, for gallant and meritorious services at the battle of Antietam.

General Newton was given the command of a division in the Rappahannock campaign, in which he was engaged in the battle of Fredericksburg. In the Chancellorsville campaign, having been in the mean time made a major-general of volunteers, he was attached to General Sedgwick's corps, counseled and participated in the storming of Marye Heights, and took part in the battle of Salem. In the Pennsylvania campaign he participated in the eventful battle of Gettysburg, and took the temporary command of the First Corps after the death of General Reynolds, and in that capacity followed in pursuit of the enemy to Warrenton, Virginia. For his gallant and meritorious services at Gettysburg he was, July 3, 1863, brevetted colonel. He still commanded the First Corps in the Rapidan campaign; but, when the "march through Georgia" was about to be entered upon, he was transferred to the Army of the Cumberland, and put in command of

the second division of the Fourth Corps (General Howard's). In this campaign he was engaged in the storming of Rocky-faced Ridge, where the corps succeeded in carrying the ridge; in the operations around Dalton, the turning of which was regarded as a great step gained in the movement upon Atlanta; in the battle of Resaca; in the action of Adairsville, where his division had a smart skirmish with the enemy's rear-guard; in the pursuit of the enemy to the Etowah River, with constant skirmishing; in the battle of Dallas; in the movement on Pine Mountain, with almost daily heavy engagements; in the battles of Kenesaw, where, in McPherson's attack on Little Kenesaw, parts of his division were engaged in the assault by which the enemy's works were reached after a charge up the face of the mountain against a heavy fire. After the crossing of the Chattahoochee River, in closing up the Federal lines around the northern and eastern sides of Atlanta, General Newton's division was left to hold an important position on Peach-Tree Creek with an inadequate force, which offered itself as a temptation to the newly appointed Confederate commander, General Hood, to attack it. The readiness with which his command met Hood's sudden assault, and the efficiency of their fire, assisted by the batteries which General Newton had posted on each of his flanks, were material in deciding the failure of that attack. For this and for other gallant and meritorious services in the campaign he was, in March, 1865, brevetted brigadier-general in the regular army.

During the siege of Atlanta, General Newton participated in the attack on the enemy's intrenchments at Jonesboro, September 18th; in the battle of Lovejoy's Station on the next day; and in the events more immediately relating to the occupation of the famous stronghold. He was afterward assigned the command of the district of Key West and Tortugas, Florida, in which capacity he was engaged in the action of the Natural Bridge, near St. Mark's. On the 13th of March, 1865—the same day on which he was brevetted brigadier-general for his services in the Atlanta campaign—he was also brevetted a major-general in the United States Army for meritorious services in the field during the rebellion. On the 28th of December, 1865, he was made a lieutenant-colonel in the Corps of Engineers. On the 15th of January, 1866, he was mustered out of the volunteer service.

He was transferred at once to engineering service, to have charge of the construction of the new battery near Fort Hamilton, in New York Harbor, and of the construction of the fort at Sandy Hook. In 1866 he made an examination for the improvement of the navigation of Hudson River, the appropriation then being sufficient only for the repair of the dikes already constructed; but his report covers the whole ground, and the scheme then proposed is that which has been carried on latterly entirely under his charge. The character of the improvements then indicated was—1. A system of longitudinal

dikes of a height not to exceed that of high water. 2. The dredging of the loose and movable material from the bottom. 3. The direction of the channel as defined by the dikes to be as straight as possible, and the changes of direction to be made by easy curves. 4. A gradual increase in width of the channel from Troy to New Baltimore as being more favorable for a higher rise of tides. 5. The closing of the side-passes generally, but leaving an opening for the influx of the flood. 6. Revetting of island-shores and river-banks where exposed to abrasion. 7. The limits of the encroachment on the river-bed to be defined and enforced by proper authority. 8. Deposition of dredged material beyond the action of currents. 9. The abandonment of the idea of obtaining a scouring effect by the height of the dikes. In fine, dikes are advocated with the view to give direction to the freshet, flood, and ebb currents; to prevent cross-currents, and consequent filling up of the channel; to lead and bring up a greater volume of tidal waters; and, consistently with these objects, the dikes should be constructed as low as possible, in order to allow the freshet-water to spread. Estimates were made for the work, to be completed in five years; it is still not complete, nor has the work been carried on without opposition from steamboat-men and parties judging that they were to be pecuniarily injured. Near Coeyman's this opposition was very strong, but, since construction, the opponents have acknowledged that their apprehensions of inconvenient results were erroneous, and have been satisfied with General Newton's engineering.

Gradually with the extension of navigation improvements General Newton reported on all the channels and harbors in the vicinity of New York, from Lake Champlain on the north to the Raritan and Arthur's Kill on the south, superintending constructions where appropriations had been granted. He was also one of the commissioners for the improvement of the harbor of Montreal.

But the great construction with which General Newton's name is identified is the improvement of the Hell-Gate Channel, the important water-way between Long Island Sound and East River, of New York city. His first examinations for the improvement of Hell-Gate, and the report, with cost of constructions, were made to Congress February 12, 1867. The first propositions were merely tentative. The plan recommended for the removal of reefs was by holes drilled from a platform above water. A contract was given to Maillefert & Co. to remove Pot Rock and some other like obstructions by depositing explosives on the surface of the rock and firing them. This was found to be very expensive and tedious, and the contractor who undertook to drill from above the water was not successful.

In June, 1869, General Newton submitted a report for the removal of Hallet's Point by sinking shafts on the shore-side to a sufficient depth, and from the bottom of these shafts running galleries under the rock to be removed, the opening below being calculated to be

sufficient to remove all the rock from above. The same project was to be applied also to the Gridiron Reef. This method of excavation was not new, as it had been proposed by General Alexander, of the United States Engineers, for the removal of Blossom Rock, San Francisco Harbor, and afterward carried out by Van Schmidt, a civil engineer; but that reef was a very small one in comparison with those to be removed at Hell-Gate. The general also, in the same report, proposed a plan for a scow to remove the isolated reefs. This scow was constructed in 1870. It consisted of an iron dome thirty feet in diameter, supported centrally in a well, in a scow one hundred and twenty feet long by forty-eight feet beam; this dome could be raised or lowered by derricks on the scow. When resting on the rock, the space inclosed was virtually cut off from all currents, the drills could be worked steadily, and the space was accessible to divers. Above the dome were steam-drills, the drills passing through tubes in the dome. This dome-scow proved a practical success, and was not only used at Hell-Gate but also on other reefs, as at Coenties and Diamond Reefs.

The progress was so satisfactory at Hallet's Point that shafts were sunk at Flood Rock in 1876. General Newton had been at the same time making extensive experiments on all the known explosives, to test their applicability to the breaking up masses of stone, while extensive experiments were also made with batteries, wires, and fuses, with a view to their use in the final blast. The excavation being completed, and the mines charged and wired, the explosion at Hallet's Point took place September 24, 1876.

It was a success. The work at Flood Rock was prosecuted more energetically, but with varying appropriations; essentially in its general features it was like the work at Hallet's Point, but with such modifications as had been developed by experience. In one essential feature both differed from what had been originally designed by General Newton. In his first report he had proposed to make the cavities of the galleries sufficient to receive the superincumbent stone. As he proceeded, he did not consider this necessary; a great deal of stone since the blast at Hallet's Point had been removed by grapples, which was practically found to be cheaper than by mining. In its application to the work at Flood Rock, the spaces were smaller compared with the solid rock than at Hallet's Point; galleries were considered only necessary to give access, so as thoroughly to shatter the rock. Flood Rock was fired on the 10th of October, 1885, and a full description of the work was furnished by General Newton for the February number of this journal.

All the problems which were involved in the several steps leading up to the consummation of that stupendous work were completely and conscientiously studied out; and the accuracy of the studies was fully exemplified in the exact correspondence of results with what was aimed

at that was realized in every part of the labors. The resources of science were drawn upon with an unerring vision of their scope; the appliances of engineering art were employed with precise adaptation to their purpose, and an exact measurement of the effect they were intended to produce; so that in all that has been achieved there has been no failure and no waste. The demonstration which General Newton has made in this work of the power of science, whose least effort can be made useful to such immense results, commands its recognition of him as its vigorous man of action. The knowledge and skill which he has thus been able to apply to such exact measurement and direction are the outcome of a life of special training and exercise; and it would be hard to produce a higher testimonial to the value of the faithful pursuit of the studies that relate to the work one is destined to do in the world than these achievements at Hell-Gate.

There is yet one enterprise connected with the improvement of the harbor of New York—the opening of the Harlem River to Spuyten Duyvel, on which General Newton reported in 1875 and 1876—which has been postponed by conflicting interests of property-owners and the difficulty of securing rights.

Since his station at New York, General Newton has often been called into consultation on many civil-engineering works. In connection with the various duties of his office his experience has been large and varied, and it would be impossible to name an engineer who has been so uniformly successful.

Recently, when the city of New York—having a more important work in view than it had yet undertaken in a municipal capacity—found it necessary to secure a man of superior skill and scientific training to superintend its Department of Public Works, General Newton's name was the first, and, we might well say, the only one that suggested itself. The only doubt expressed on the subject was whether he would be willing to leave the body with which he had been connected all his life, with such distinguished honor, for one the record of which has not always been free from the taint of political manipulations. This question was happily solved by General Newton's declaration of his willingness to accept the position on the retired list of the army, to which he was entitled, in order to go to the place where he was more needed. The fitness of his appointment has been universally recognized, and is most felicitously expressed in the words of one of the newspapers, that he is the "ideal man" for the position.

CORRESPONDENCE.

THE PHYSIOLOGY OF EXERCISE.

Messrs. Editors:

WHILE all must agree with Professor Richards as to the importance of physical exercise to the brain-worker, there are some points in his article on "The Influence of Exercise upon Health," in the "Monthly" for July, 1886, requiring comment.

On page 328 he says: "When we use our muscles, their contractile force upon the blood-vessels helps the blood along its channels, and thus takes a little labor from the propelling heart. It beats faster, but with less effort."

It is admitted that contracting muscles by their lateral pressure promote the flow of blood through the veins; but the work of the heart is not lessened thereby, because the force of the heart-beat is not expended in propelling the blood through the veins, but (according to Foster) in expanding the elastic arteries and overcoming the friction between the blood and the walls of the arteries and capillaries. This friction is called the peripheral resistance. Now, whatever diminishes the caliber of the terminal arteries and capillaries increases the peripheral resistance; and, if the contracting muscles have any effect upon these vessels, it is to lessen their caliber and so increase the peripheral resistance, thus throwing more work upon the heart.

The heart beats faster, but does it beat with *less effort?* Du Bois-Reymond ("The Physiology of Exercise," "Popular Science Monthly," July, 1882) says: "Under continuous severe exertions, as in mountain-climbing and long walks, the heart begins to beat faster and *more strongly;* because, according to Traube, it is stimulated by excess of carbonic acid formed in the laboring muscles; according to Johann Müller, because it participates in a by-motion."

How is it, if muscular exercise lessens the work of the heart, that excessive and long-continued muscular exertion causes hypertrophy and even valvular disease of that organ? Yet such is the case, according to such eminent authorities on medical matters as Drs. Da Costa, A. L. Loomis, the late Austin Flint, and others. This is a matter of great importance from a medical standpoint, for, if muscular exercise lessens the work of the heart, our medical writers have all gone wrong in saying that the most essential item in the treatment of a diseased and overtaxed heart is rest.

Again, the professor quotes Maudsley as follows: "By one organic element of the body the blood is purified from the waste matter of a higher element, which would be poisonous to it." This is undoubtedly true. The lungs, kidneys, and other excreting organs certainly do eliminate materials which would be poisonous to other organs. But Professor Richards applies this remark to the muscular and nervous systems, which, I think, he is not warranted in doing, as I shall endeavor to show.

He says (page 332, July "Monthly"): "A tired brain and quivering nerves may not be more wearied by physical exercise, but may be refreshed by it. This refreshment may result from two processes: First, by drawing the excessive blood-supply from the before active organs; and, secondly, by purifying the blood so that it may be ready to properly nourish the brain."

In the first place, it is not the excessive blood-supply that makes the brain tired, the increase of blood being caused by the increased demand of the functionally active organs. In the second place, contracting muscles, as the result of the chemical changes that take place in their substance, form lactic acid, keratin, and carbonic acid. The last, according to M. Foster ("Text-Book of Physiology"), acts upon the central nervous system as a narcotic poison. The brain forms keratin during functional activity. Now, since one product of muscular action is a narcotic poison, and another is a waste product of the brain, it is inconceivable how the blood is purified and better fitted to nourish the brain.

If, as Professor Foster says, "the fatigue of which, after prolonged and unusual exertion, we are conscious in our own bodies arises chiefly from an exhaustion of the central nervous system concerned in the production of voluntary impulses," then Professor Richards's statement, that the time for exercise is when the brain is tired and one feels inclined to rest and to forego exercise, is open to question. May it not be that the indisposition to take active exercise when fatigued by brain-work is rather conservative, just as is the natural tendency to rest after a full meal during the process of digestion? Respectfully,

A. B. ROSENBERRY, M. D.

SHEBOYGAN FALLS, WISCONSIN, *July* 8, 1886.

A CURIOUS OPTICAL PHENOMENON.

Messrs. Editors:

A STRANGE phenomenon was observed here at a few minutes before sunset yesterday evening. A heavy storm had come up

in the afternoon, and during a cessation, shortly before sunset, the light burst through the clouds in the western sky and a most magnificent rainbow appeared in the east, with the top of the circle about fifty-five degrees from the horizon. All that portion of the clouded sky within the circle changed to a brilliant red color, while all without the circle was of a dull bluish-gray shade. The rainbow thus formed a sharp division between the two portions of the sky which were in such striking contrast to each other. For a time the red sky inclosed by the rainbow was so deeply colored that the red portion of the rainbow, which was in itself remarkably brilliant, could not be distinguished from it, but it appeared as though the red part of the rainbow had spread out, covering the entire plane inclosed within the circle. A similar phenomenon never having come before my notice, and having never read an account of one, I would respectfully ask the editors of "The Popular Science Monthly," or the intelligent readers thereof, to furnish me with an explanation. Why should the red portion of the clouded sky within the circle and the bluish-gray portion without be so sharply defined and divided by the rainbow?

Very respectfully, B. F. THOMAS.

MORNING SUN, IOWA, *August* 14, 1886.

"ANIMAL AND PLANT LORE OF CHILDREN."

Messrs. Editors:

READING "Animal and Plant Lore of Children," in your publication for July, called to mind a few beliefs that children had in Southern Illinois twenty years ago, and which were not enumerated in the article referred to. Snakes were numerous, and the subject of many superstitions. To kill a snake and hang its body on a living bush would produce rain within twenty-four hours. Snakes delight in the hot sun-rays which precede a thunder-shower, and are often killed at such times. It was a general belief that live coals placed on a snake would cause four legs to grow from its body. To inhale the breath of a snake was sure death to the child who met with such an accident. Children were firm in the belief that snakes could charm them if they gazed steadily at the reptiles' eyes. It was bad luck not to kill the first snake seen in the spring. The negro children believed that the lives of snakes were guarded by the devil.

The "tobacco-juice" expectorated by grasshoppers was a sure cure for warts. Bean-leaves not only cured warts, but killed cancers.

Bad luck befell the person who saw a rabbit cross his path, unless out on a hunting expedition. If a child killed a cricket, his clothes would be ruined by other crickets.

Toads or humble-bees entering the house were as sure signs of company as the crowing of a rooster at the front door.

Frost always made its appearance just six weeks from the time the first katydid was heard.

Cats were credited with nine lives, and turkey-buzzards with the power to vomit on naughty children.

In fishing, a few drops of blood on the bait were more valuable than spit or hare callosity. The latter was also a cure for toothache.

The ant-lion was enticed from his den by repeating, "Noodle! noodle! come out of your hole!" He was then punished by death for being so easily fooled.

Purposely to kill a lady-bug would cause sickness, and accidentally to do so, some kind of bad luck.

Many of these beliefs were held by grown persons as well as children, while adults had many superstitions which children could not understand.

H. M. WHELPLEY.

ST. LOUIS, MISSOURI, *July* 10, 1886.

EDITOR'S TABLE.

FRAUD AND ITS VICTIMS.

NOTHING could better illustrate the great need that exists, even in this highly favored country, for a more general diffusion of intelligence, than the extent to which people, who can at least read and write, allow themselves to become the dupes of the most transparent impostures. The post-office authorities are engaged in a perpetual struggle to prevent people, who would be deeply offended if they were spoken of as deficient in intelligence, or if any one hinted that they were not fully, if not superabundantly, qualified for the highest duties of citizenship, from parting with their money to impudent adventurers who advertise their ridiculous and utterly fraudulent schemes in the newspapers. At one end of the coun-

try is a lottery, at another a mining speculation; here a gift concert, there a family newspaper sent free for six months with valuable premiums into the bargain; one man has a remedy for every form of disease, another is prepared to reveal an easy and delightful way of making a fortune in a few weeks: it matters little what the pretense is, the fly is no sooner cast than some silly fish begin to rise. Those who pride themselves on being more knowing than their neighbors nibble a little at the bait at first, and enter into correspondence with the advertiser. The latter knows just what to do with such customers. He sends them the most solemn protestations that his business is *bona fide*, and his personal reputation beyond all possibility of attack. He is prepared to show testimonials by the thousand as to the thorough uprightness and eminently satisfactory character of his dealings. That is enough: the money comes forward by the next mail, and one more gudgeon is hooked.

It may be asked what all this has to do with science. Well, a good deal; or, if not with science, at least with the want of it. What are the schools of the country doing, let us ask, that the Post-Office should have to step in to save the free and enlightened citizens of this republic from the consequences of their own ignorance and folly? The object of popular education, we make bold to say, ought to be to give the people sense; yet here we have indisputable evidence that large masses of our population don't know enough to protect themselves against the most barefaced forms of imposture. The intellectual quality most largely developed in certain extensive regions of society would seem to be credulity. How does this fact tally with our supposed educational progress? Evidently we are here face to face with a question which should come home very directly to all who are interested in public education; and we would respectfully ask teachers and trustees to consider whether, through the schools, something might not be done to diminish an evil which really has assumed very large proportions. Let *private* education pursue what ends it will; but public or state education, we hold, should aim, above all, at the production of good and efficient citizens. But a man is not an efficient citizen who is so grossly credulous as the majority of those who fall a prey to the advertising quack or confidence-man. A part, and no mean part, of the exercises of every school should consist of the imparting to the pupils of sound practical precepts bearing on civil and social life. We want to develop common sense in the young; we want to give the boys a manly bearing and manly ideas; we want to qualify the girls to act with sound judgment and right womanly feeling in the several positions in life they may be called upon to fill. We want to show that the lust of wealth is a poor motive for any man's or woman's chief activity. But how is all this to be done? The mere teaching of arithmetic, geography, and grammar will not do it. It can best be done, as it seems to us, by a scientific, that is to say, a rational exposition, on the one hand, of the principles which go to produce the dignity, security, and happiness both of nations and of individuals; and, on the other, of the causes which lead to national decay and individual misery. In connection with such a course of lessons as we have now in view, it would be well to glance at some of the methods by which dishonest men prey upon society, and, by way of illustration, we can hardly imagine anything more serviceable than an analysis of the advertisements and circulars of some of the "frauds" operated through the post-office. The children who heard these things exposed would carry home the information to their parents; and the net result in many cases would be an en-

largement of the common sense of the household, and the saving of a good many dollars of hard-earned money. It may perhaps be objected that ill-disposed boys would thus learn tricks that they might afterward attempt to practice. The same risk, however, attends every exposure, in the press or elsewhere, of vice or crime; and we think that an honest teacher could hardly fail to present the subject in a manner that would leave a large balance of good effect.

If there is anything that schools maintained by the State might be expected to do, it is to inculcate respect for the State, and in general to develop a sense of the debt which each individual owes to the society of which he forms a part. Nothing is easier to show than the entire dependence of the individual upon society for all that makes life worth living; and it ought not to be impossible to draw out certain feelings of regard and devotion toward the organism in which and through which alone individual life rises to any true worth or dignity. It can be shown that, just as the family, in the first place, educates the individual by taming his selfishness and developing his sympathies, so the State or community educates the family by widening its interests, multiplying its activities, and calling into existence those thousand differentiations, complications, and refinements of thought and feeling which distinguish civilized man from the savage. Were these lines of thought properly worked out, we believe they would be found to furnish the basis for an almost religious sense of duty to the State; and would certainly set in a strong light the odiousness of such treason to it as is involved in private fraud and in public corruption.

We shall only say in conclusion that it would, in our opinion, be well if the public would get more and more into the way of testing our school systems by their apparent practical results as regards the moral and intellectual life of the community. We ought to be able to form some idea as to whether the rising generation are growing up wiser and better than ourselves, or just about the same, or worse. We should postulate distinct improvement; and, if such improvement is not apparent, we should try to find out the reason why.

THE BUFFALO MEETING OF THE AMERICAN ASSOCIATION.

The American Association met this year in its thirty-fifth meeting at Buffalo. It is the third time it has assembled in that city, its fifteenth and twenty-fifth meetings having also been held there. It is also a fact, of which the people of Buffalo took notice with a gratification they had a right to feel, that their city is the first place which has as yet enjoyed the privilege of entertaining the Association for the third time. The Hon. Sherman S. Rogers, who delivered one of the addresses of welcome, referred to the fact as significant of a growing regard among the people for those pursuits which contribute to the advancement of knowledge, irrespective of their bearing upon business, and as evidence that, eager as that active and enterprising city is in the material pursuits of life, "it is waking up to the conviction that man does not and can not live by bread alone." The same thing is going on in the other cities of the country, large and small, where increased appreciation is shown every year of those things which pertain to learning for its own sake, and where even the most active centers of commercial speculation have their academies working industriously in pure science.

The attendance was good, and the list of members is marked by the presence of a large proportion of those who have attained a solid reputation in their respective branches of science. The programme of the papers also exhibits

a greater predominance than has usually obtained of late years of those that are of real scientific or practical value, with a corresponding absence of the vagaries of such persons as President Morse described as "cranks." Retiring President Newton selected meteorites as the topic of his official address, which we publish entire in this number of the "Monthly," the subject with the investigation of which his fame is most closely associated. With a few plain, common-sense considerations which everybody could comprehend, expressed in language intelligible to the most unlearned of his possible hearers, he disposed of most of the theories which have been devised to account for these phenomena, showing how inadequate they are, and then considered, without committing himself definitely to what no one knows, the only one yet advanced which is plausible in the present condition of science. Of the vice-presidential sectional addresses, that of the Hon. Horatio Hale, in the Anthropological Section, presented the subject of "The Origin of Languages and the Antiquity of Speaking Man," in a somewhat different light from that in which it has been regarded by the majority of anthropologists of the present generation. Professor Wiley's address on the "Economical Aspects of Agricultural Chemistry" is of practical interest, and will probably attract more general attention. Professor Brackett's address in physics, and Professor Bowditch's in biology, are of technical interest. In geology, Vice-President Chamberlain presented "An Inventory of our Glacial Drift." Vice-President Chanute, in the Mechanical Section, showed how inventors are indebted to science; and in the Economical Section Vice-President Cummings considered the well-worn questions of the improvement of the condition of laborers, the causes of discontent among them, and their errors. The Association meeting so near to Niagara, the geological origin and character of the Niagara River and Falls naturally claimed a large share of attention. A graceful recognition was made of the approaching completion of the hundredth year of the veteran chemist, Chevreul. In commenting upon the meeting of the Association in Buffalo ten years ago, we spoke of a seeming lack of papers and discussions suited to the wants of the citizens at large who attended the sessions in expectant interest. We observe in the proceedings of the present meeting an improvement in this respect. While the technical side was not overlooked, and little that was unscientific was presented, the addresses of President Newton and Vice-President Wiley, the Niagara discussion, and other papers to which we have referred, were, both in matter and manner of presentation, well adapted to a popular audience.

LITERARY NOTICES.

OUTLINES OF THE HISTORY OF ETHICS FOR ENGLISH READERS. By HENRY SIDGWICK. London: Macmillan & Co. 1886. Pp. 271. Price, $1.50.

LEAVING Herbert Spencer out of consideration, no living or recent writer has made an impression on ethical thought equal to that of Professor Sidgwick. Whatever he produces, then, might naturally be expected to be of value. Our anticipations are not disappointed in this little volume. As far as it goes, it is, without doubt, the most thoroughly admirable treatise upon the history of ethics extant. This praise is due for its conciseness, for its impartiality, and for its accuracy. It is an excellent college text-book, and also full enough to give the general student a better idea than he can elsewhere obtain of that portion of ethical history which it covers.

This book is by no means a mere chronology. It is full of the evidences of careful critical study. The essential features of the different ethical systems are grasped with certainty and presented with remarkable clearness. We get from this presentation many new ideas, both of the tenets

of philosophers and their true relationship to each other. The points of agreement, for example, between Plato and Aristotle, as indicated by the author, are very impressive. The relations of pre-Socratic ethics to these latter are well shown. The translation of εὐδαιμονία by "well-being," instead of the usual "happiness," gives us quite a different conception of much of the Greek ethical philosophy. The contrasts between Stoicism and Epicureanism are sharply and truthfully drawn. The influence of the Roman jurisprudence upon ethical development is exhibited in a manner indicating the author's knowledge and appreciation of the work of scholars like Sir Henry Sumner Maine. Mediæval ethics and Christianity are treated without leaving the reader's mind in a state of hopeless confusion respecting the landmarks of progress and the work of individuals with whose names we are familiar, but of whose special value we can ordinarily learn but little from philosophical and religious histories. The chapter on modern English ethics is conspicuously free from controversial matter and from the *animus* of the partisan. All through, we find new ideas which reveal critical acumen, and compel us, if not to change, at least to reconsider our conclusions on many special points of historical fact. For instance, we are somewhat startled by the opinion that in the latter part of Plato's life, when he wrote the "Timæus," he did not believe in the immortality of the individual soul. Again, the average reader will probably be somewhat surprised to learn that Bishop Butler held self-love and conscience to be independent principles, and so far coordinate in authority that neither should be overruled by the other; if either were to give way, it must be conscience. Also, the importance of such works as Price's "Review of the Chief Questions and Difficulties of Morals" (1757), and Gay's "Essay," prefixed to Law's translation of King's "Origin of Evil" (1731), in the history of English ethics, is seldom considered and nowhere else saliently brought out.

All these considerations awaken regrets that the work before us is avowedly incomplete. The author says, by way of explanation, that, since the foundation of this book was an article written for the "Encyclopædia Britannica," after some hesitation he concluded to retain his original plan, and deal only with modern ethical systems as they relate to English moralists. We think this was decidedly a mistake. It detracts very considerably from the usefulness of the treatise. There is no utility, even for English readers, in presenting the ethical movements of Continental thought as an appendage to English ethics. The French and German systems have contributed powerfully to form the principles of morals, and very extensively to determine character and conduct. The French Revolution was primarily a political convulsion, but the ethical influences contributing to bring it about, and which it in turn generated, were very noticeable and important. They ought to be fully traced out in a history of ethics. So, too, the Kantian philosophy is surely worthy of a more thorough exposition and criticism than that of a half-dozen pages at the end of the volume. Again, the leading phases of Oriental ethical development are of the highest consequence in such a history. These defects could have been supplied, not, indeed, without enlarging the book; but we think the resultant advantage would have been ample justification for the addition.

NUMBERS ILLUSTRATED AND APPLIED IN LANGUAGE, DRAWING, AND READING-LESSONS. By ANDREW J. RICKOFF and E. C. DAVIS. New York: D. Appleton & Co. Pp. 160. Price, 42 cents.

THIS is an arithmetic for primary schools, and is the first in the series of "Appletons' Standard Arithmetics." It is the fruit of many years of careful preparation, combined with extended research as to the best methods now in use, and much experience in class-room work and school supervision. Its design is to familiarize the child with numbers and their combinations by some better and more lively method than the mechanical and rote repetition of the formulæ of the addition and subtraction and other tables. Instead of this, it attempts to provoke observation of the things the numbers represent, and to lead the pupil to the utterance of the formula as a statement of his own experience. In the earlier lessons, in the first part of the book, the properties of numbers are illustrated by the aid of three series of pictures

for each of the digital numbers. The pictures of the first series are designed for language-lessons, in which the particular number is brought in and visibly represented, and the immediate design of which is to excite thought and cultivate expression. The second series consists of slate exercises involving the numbers to be copied with changes; and these are afterward changed into diagrams, combining exercises in elementary drawing, into which the several numbers also enter. The third series of pictures, entitled "What can you tell?" presents combinations, with the numbers still the most prominent objects to be considered, which the child is invited to describe, or concerning which he may compose a story—exercises which call the imagination into play, and encourage independent and original expression. These lessons are followed by a series of reading-lessons in number and dictation exercises, in combinations of from one to ten, with the pictorial element still employed. In the third part are given combinations in numbers from ten to twenty.

GEOLOGICAL STUDIES. By ALEXANDER WINCHELL. Chicago: S. C. Griggs & Co. Pp. 513. Price, $3.

THIS book, representing a more advanced stage of the study of geology than is furnished in the author's "Geological Excursions," is intended to introduce the reader to the science by some natural and pleasant method; to help him to see things for himself, and draw his own conclusions from them. It is, therefore, designed to be a guide to the observation of Nature, and a synoptical record of the more important facts and doctrines of the science. It is divided into two parts: "Geology inductively presented," and "Geology treated systematically." Geology is the science which treats of the earth; the earth is under our feet; let us, therefore, the author says, "direct our attention to it, and see what facts may be observed. These will be geological facts. Every fact learned by observing the earth is part of the science; and the things observed near home are just as real science and just as important as those in distant lands, of which we may read in the books." The drift being nearly everywhere, the reader is invited to make that the special subject of his study. He will find in it representations of a great variety of geological phenomena and formations, minerals and fossils. He can make the facts he learns from it the basis of his more extended studies in excursions, or in books, after he has well traversed the field in which he is able to make excursions. The outcome of the first, or inductive, part of the book, in which the course is carried far enough to illustrate how to study fossils in a scientific way, "is a somewhat chaotic and undigested mass of facts and doctrines buried in a considerable volume of verbiage. It does not assuredly supply the means for a methodized apprehension of the elements of the subject, but it supplies many fundamental facts, many great principles, many impressions, many hints for personal observation, and many impulses to continue. Far better for the student to get so much than to leave school in total ignorance of a science which sustains so important relations to industries, to culture, and to civilization. Part II is the complement of this. Here the whole body of facts and principles is reduced to a methodical representation. . . . Here, too, the discussions of the several topics are completed, and the various portions are adjusted to a logical relation." The book treats principally of American geology, and in this all the recent additions, which have transformed the science so that "the subject has to be treated very much as if no elementary book had been written," have been made use of. The motto of the first part is, "How we may observe the facts, and learn their meaning." The successive chapters of the second part, which are divided into many special sections, treat of "lithological," "structural," and "dynamical" geology, the "progress of terrestrial life," and "formational" and "historical" geology.

GUIDE TO THE RECOGNITION OF THE PRINCIPAL ORDERS OF CRYPTOGAMS, AND THE COMMONER AND MORE EASILY DISTINGUISHED NEW ENGLAND GENERA. By FREDERICK LEROY SARGENT. Cambridge (Mass.): Charles W. Sever. Pp. 78.

THIS book was prepared for the use of students in the summer course in botany at Harvard University, in which the author is

a teacher. It is intended to present the distinctive characteristics of the genera of the family, which are not described in the usual text-books, with sufficient compactness for easy use in field-work. The attempt has, therefore, been made to bring together, in systematic form and a convenient shape, such information as would enable a student to learn to recognize a number of the more conspicuous genera. Half of the leaves are left blank for the convenience of students wishing to insert notes and sketches.

HISTORY OF CALIFORNIA. By HUBERT HOWE BANCROFT. Vol. IV. San Francisco: A. L. Bancroft & Co. Pp. 786. Vol. V. San Francisco: The History Company. Pp. 784.

THE fourth volume continues the history as to general affairs from 1836, and as to local affairs from 1840 to 1845. The story of the secularization of the missions is carried on. Among other topics of interest, the doings of foreigners, American occupation, the "Graham affair," the coming of Sutter, and the establishment of New Helvetia, are treated in a new light. The career and character of Sutter—whose story is closely connected with the awakening of the gold-fever and the occupation of the country by American miners—are reviewed in full. This man hardly appears here as the public-spirited citizen which many have been disposed to regard him, but as a reckless adventurer and speculator. The records of the several overland immigrant parties are given, beginning with the Batterson or Bidwell party, in 1841, and including the companies of Workman and Rowland in the same year; of Hastings, Chiles, and Walker, in 1843; of Fremont, Kelsey, and Stevens, or Murphy, in 1844; and of McMahon and Clyman, Swasey and Todd, Sublette, Grigsby, and Ide, Fremont and Walker, and Hastings and Semple, in 1845; also accounts of Commodore Jones's achievements in 1842, of the Russians who left California in 1841, the Hudson Bay Company's branch in San Francisco, the fur-hunters' operations in the interior, and the trading-caravans from New Mexico. Prominent among the topics of foreign relations are the schemes of France, England, and the United States, to gain possession of California; and particular attention is given to the plans and efforts of the United States and its agents, as shown in original correspondence, now given to the public for the first time; and the treatment of American immigrants down to 1845 is set forth.

The fifth volume comprises—from 1846 to 1848—the exciting period of the conquest of California by the United States, which is treated in all its phases. The policy of our Government and the doings of its agents are studied from documentary sources not hitherto brought to light. Hence the volume is likely to prove, as a narrative, more interesting and readable than any that have preceded it; and it can not fail to be important as a record, because it is founded largely on original testimony. Its contents embrace, first, the acts of Fremont in the country, which are set forth in an unfavorable light; next, the personal and sectional controversies that marked the last days of Mexican political annals. A following chapter is devoted to foreign relations, the policy of the United States and other nations, and the efforts of Colonel Larkin; another chapter to the causes of the settlers' revolt, wherein Fremont is again handled with severity; and four chapters to the detailed presentment of the "Bear Flag" revolt; after which begins the story of the conquest proper as part of the Mexican War. This having been told, the political controversies of Stockton, Kearney, and Fremont, next claim attention. The stories of the Mormon Battalion, the New York Volunteers, and the Artillery Company, are given; also the annals of immigration, including the tragic experiences of the Donner party and the coming of Sam Brannan's Mormon colony; the history of the ex-missions and of Indian affairs, with the annals of trade, and other incidents, going to complete the history. The pioneer list is completed, and includes in all some ten thousand names and biographical sketches. Our heading indicates a change in the name of the publishing house. A story is connected with the change. The whole establishment was burned down last April, with an inadequate insurance. Mr. H. H. Bancroft was the principal proprietor, and lost very heavily, not only through his share in the

business, but also in the destruction of the plates of nine volumes of the history, and of the whole edition of the first volume of the "Oregon." In rebuilding and reorganizing the concern, it was necessary to dispose of a part of the business. Mr. Bancroft, having determined to devote his life to the history, resolved to sacrifice all to that. Hence the new concern is formed as "The History Company," and its peculiar work till that is done will be to bring out this "History."

PHYSICAL TRAINING IN AMERICAN COLLEGES AND UNIVERSITIES. By EDWARD MUSSEY HARTWELL. Washington: Government Printing-Office. Pp. 183, with Plates.

THIS is one of the "Circulars of Information" of the Bureau of Education, and is published at the request of the commissioner. Dr. Hartwell makes a comprehensive and satisfactory presentation of the subject. He begins with a sketch of the "ideals of manly excellence" and a running history of gymnastic training down to the time of Fellenberg and the Hofwyl schools; then describes the "Introduction of Gymnastics into America," from the starting of the Fellenberg schools in 1824 and 1825; relates the development of the "New Gymnastics," and records the history of the building of gymnasia in colleges. The particular accounts of the principal college gymnasia and gymnasia of the Young Men's Christian Associations are illustrated with views and plans of buildings. Tables are given exhibiting the facts that twenty-six colleges in the United States have buildings exclusively devoted to gymnastic purposes, the cost of which, including fittings, is estimated at $750,000; and twenty other institutions have gymnasium or drill-halls. Nine theological schools also have gymnasia. During the year ending July 1, 1884, thirty-three officers of the army were detailed to duty at colleges, universities, and schools of superior instruction to young men, for giving military drill. College athletics have been most developed in the East, and particularly at Harvard, Yale, and Princeton. At most country colleges ample facilities in the way of grounds are furnished for the playing of base-ball, foot-ball, and tennis; and since track athletics, or walking, jumping, sprint and hurdle races, have become popular, very considerable sums have been spent on the grading and improvement of athletic fields. "Exhibitions and contests of every description which would not have been licensed or tolerated, much less pecuniarily supported, thirty years ago, now yield quick and large returns in popularity and cash to their promoters." On the subject of college athletics, the report draws largely upon the article of Professor Richards in "The Popular Science Monthly" for February and March, 1884, which is pronounced "the fairest and most intelligent paper elicited by the recent discussion of athleticism which has come under our notice," and one in which "the whole system is so well set forth, its advantages are so cogently argued, and the attacks of its critics so temperately met, that it seems best to quote copiously from it. Its exposition of the reciprocal relations of body-work and brain-work should be grasped by every teacher." But professionalism, defined as "the purpose to win a game by any means, fair or foul," has come in to bring discredit upon college sports, and make recognition and regulation of them by faculties necessary; and what has been done and attempted in this direction is reviewed. Women's schools and colleges are not, as a class, so well organized on the side of physical training as those for men, but something has been done in a few of them, and the Association of Collegiate Alumnæ is laboring to awaken interest in the subject. A sketch of the condition of physical training in Germany forms an appendix to the report.

REPORT OF A COMMISSION APPOINTED TO CONSIDER A GENERAL SYSTEM OF DRAINAGE FOR THE VALLEYS OF MYSTIC, BLACKSTONE, AND CHARLES RIVERS, MASSACHUSETTS. Boston: Wright and Potter Printing Company. Pp. 243, with Plates and Maps.

THE commission was appointed in 1884 to consider and report a general system of drainage for the relief of the valleys of the rivers named, and for the protection of the public water-supplies of the cities and towns situated within their basins; also to examine the various methods of disposal of sewage. And it was further authorized to consider and report upon the needs of any

other part of the Commonwealth as to the disposal of sewage and the protection of the public water-supplies therein. Its report is a carefully matured and valuable document, in which the subject is viewed under its various aspects, and results are given that may aid in forming judicious conclusions wherever problems of sewage disposal may present themselves. The bulk of the volume is given to the report of the engineer of the commission, Mr. Clarke, who first defines the problem in its general and detailed features, gives an account of all the elements that contribute to stream pollution in each town, the manner and present expense of dealing with a part or all of the objectionable matters, and refers to what actions have been taken or what opinions have been held by the local authorities on the subject. In a second part of the report he presents the general conclusions arrived at, in England and elsewhere, as to the best methods of sewage disposal under conditions similar to those of Eastern Massachusetts. This part is illustrated with particular accounts of the operation of the methods by filtration, irrigation, precipitation, etc., which are used in various towns in England, and photographic views. In the third part the conclusions with reference to methods are applied to each particular locality in the district whose needs are to be provided for. Among the engineer's conclusions is the hopeful one that manufacturers, as a class, are very intelligent, and there is no limit to the ingenuity they have displayed in devising processes and machinery for accomplishing desired ends. This ingenuity hitherto has not been directed toward purifying their refuse, because such purification has not been considered necessary. The mechanical problems involved are not so difficult but that they probably can be solved, if only intelligent efforts and experiments are made in that direction. As an offset to this is the fact, not so encouraging, that "it is much easier to design a proper system of sewerage than to remedy the defects of one already constructed. Indeed, thoroughly to do the latter is well-nigh impossible. Unfortunately, the sewers in many towns of the State have been built piecemeal and without any system. First, a single drain is built, chiefly to remove surplus rain-water. It discharges little or no sewage, and the pollution of the outlet is thought to be unimportant. House-drains are afterward connected with it, so that it assumes the functions of a sewer. Then another branch sewer connecting with it is built, and from time to time more are added. So a network of pipes grows up, without system, and without adaptation of one pipe to the others. The sewers work badly, and the amount of sewage discharged at the outlet begins to make a nuisance. Then, perhaps, but not before, some expert in sewerage is called into consultation. It is, however, too late—the mischief has been done—and he rarely can suggest any but palliative measures, unless the town is willing to abandon all of the work already done, and begin again *de novo*. Many nuisances and much expense would be avoided if it were required in the future that no towns should be allowed to build sewers except such as formed parts of a well-digested scheme for the whole town; which scheme provided for the proper disposal of the present and prospective amounts of sewage, and had first been submitted to, and approved by, some experts appointed by the State. The same principle applies to manufactories."

THE SCIENCE OF BUSINESS. By RODERICK H. SMITH. New York: G. P. Putnam's Sons. Pp. 182.

THE author presents this essay as "a study of the principles controlling the laws of exchange." He believes that the course of business is governed by fixed natural laws, and that those laws correspond, as it were, with the law of motion, which goes along the line of least resistance, and is also subject to the law of rhythm. By the latter law, the ups and downs of business are regular in their recurrence, or periodical. No attempt to account for commercial fluctuations can be successful that loses sight of this. We may assign what particular causes may be most apparent for the stimulation of speculative movements or for the prevalence of failures. They may all have their influence; but that influence works in with the rhythmic movement, not against it or independently of it. The author calculates

the period of the rhythmic wave to be about ten or eleven years; and according to his computations the period of depression in which we are now supposed to be sinking is to culminate in 1887. Curiously enough, he predicts—it was a prediction when he wrote it—that "during the years of depression into which we are now entering — 1885, 1886, 1887 — we may expect numerous strikes, mobs, and troubles in our cities among laboring classes, incident to such times." While Mr. Smith's theory must be classed in the long list of hypotheses very much in need of proof, it is fair to say that he does not write like a wild visionary, but in the manner of a capable man who has thought long and earnestly upon the question he discusses.

THE FITTING-SCHOOLS. By G. VON TAUBE. New York: Gramercy Park School and Tool-House Association. Pp. 86.

THE author is the originator and present director of the Gramercy Park Tool-House, and considers in this pamphlet the educational methods followed there—which attempt considerably more than simply to introduce the tools, or to train a future mechanic. From the statements of his theory of education we cite this about the primary work, or purpose, of the Kindergarten, which "is generally accomplished, *notwithstanding* the school. The early culture of perceptions goes ahead according to Nature's rules, even if the A B C remains unmastered. And facing the fact that a great deal of the very Kindergarten work is not wisely (we should say philosophically) arranged and conducted, we are obliged to come to the conclusion that the knowledge how to lose time wisely is the best maxim to be followed at an early age of the child. What has to be attended to is the discipline of habits, that of steady preoccupation, a concentration of attention leading to future thoroughness. Then the habit of neatness, that of sociability, the early sympathy toward a sufferer, a good, square, friendly acquaintance with Mother Nature's objective department. . . . Thus the creation of a good motive in children depends greatly upon careful early management, and the spontaneous activity of the little ones is made available to that effect." Arriving at the age of generalizations the study is directed toward new and wider subjects—a higher analysis of life and its conditions. In the conclusion—"Education, let us believe, is a specialty, is a serious study; not a personal opinion on a light subject, but a generalization, the inductions of which extend through centuries, whose truths call for testimony of most mixed sciences. Education, therefore, as a science, can no more be mixed up with emotional ventures and declamations than physics, chemistry, or astronomy. The future of a generation, embodying the dearest we possess on earth —our children—is too serious a matter to be settled off-hand, or to be indiscriminately and blindly deduced from a few principles, even if these should be of the highest kind."

ANTHROPOPHAGY, HISTORIC AND PREHISTORIC. By General CHARLES W. DARLING, Utica, N. Y. Privately printed. Pp. 47.

THE author, in his readings relating to the origin and history of the human family, was impressed with the frequent allusions to man-eating among many of the peoples of the world, and was prompted to collate some of the references to the custom, in a connected form. In doing this, he has endeavored to be faithful to the facts as related by historians and travelers. His record begins with the Cyclopes of the Greeks, and ends with the distressing incidents of the Grecly Expedition.

PROCEEDINGS OF THE SIXTH MEETING OF THE SOCIETY FOR THE PROMOTION OF AGRICULTURAL SCIENCE. 1885. B. D. Halsted, Secretary, Ames, Iowa. Manhattan, Kansas: State Agricultural College. Pp. 59.

THE society was organized in 1880, for the purpose of bringing together those who are interested in the applications of science to agriculture, discussing the methods and results of investigations, and providing for publications relating to the same. The present meeting was held at Ann Arbor, Michigan. Among the papers recorded in the report are—"The Vitality of Seeds buried in the Soil," by W. J. Beal; "The Demands made by Agriculture upon the Science of Botany," by Charles E. Bessey; "On Some Redeeming Traits of Alkali Soils,"

by E. W. Hilgard; "An Investigation of the Origin of the Dandelion," by E. L. Sturtevant; and an account of some experiments on "Variation in Cultivated Plants," by W. W. Tracy. In his observations on the last subject, Mr. Tracy finds many illustrations of variations of type which cultivators had been trying to produce for years, appearing in different localities and from different stocks at about the same time, so as to seem to indicate that variation is not an accident, but a progression of the species.

THE JOURNAL OF PHYSIOLOGY. Edited by MICHAL FOSTER and others. Vol. VII, No. 1. Cambridge Scientific Instrument Company's Works, Cambridge, England. Pp. 80. Price, $5 a volume, of four numbers.

WE notice this "Journal" at the beginning of its new volume, because it is one of the principal recognized mediums through which original investigators in physiology make known the results of their work. Research in this branch of science is now very active, and is distinguished by minute attention to details. It is the custom of the "Journal" to publish the particular accounts of the experiments and conclusions of investigators, with a fullness and excellence of pictorial illustration that leave nothing to be desired. Professor Foster, as editor of this publication, is assisted in England by Professor W. Rutherford, of Edinburgh, and Professor J. Burdon-Sanderson, of Oxford; and in America by Professor H. P. Bowditch, of Boston; Professor H. Newell Martin, of Baltimore, and Professor H. C. Wood, of Philadelphia. The present number is occupied with a paper by W. H. Gaskell, "On the Structure, Distribution, and Function of the Nerves which innervate the Visceral and Vascular Systems."

SCIENCE AND THE STATE. By R. W. SHUFELDT. Pp. 10.

DR. SHUFELDT advocates patronage of science by the Government, and argues that it must be a good thing because the Government already fosters some dozen or more scientific bureaus at its seat, and they are all thriving. He would extend the scope of these bureaus, and the patronage of the Government, and would have organized at Washington a Department of Science, with buildings and a dozen sections, and a Cabinet officer—the Secretary of Science—to preside over the whole. The "Monthly's" opinion of schemes of this kind and its reasons for holding it have been often enough and plainly enough expressed, and need not be repeated. Happily the author—although his reference is to officers of the army and navy already in Government employ having a taste for science overruling that for their real business—has made a very terse statement of the real attitude which the Government should occupy toward scientific students. It is that it "should offer the constant opportunity to such men to do the work for which they were born, molded, and designed, but allow them to do it in their own way, at their own times, and absolutely unhampered by any but the most necessary regulations." This maxim may apply to officers in time of peace, when the corps are kept up merely for the sake of having them on hand. Broadened, and with the addition of "at their own expense or that of their friends," it would make a most excellent rule of universal application, and would convey the true doctrine.

THE COUNTRY BANKER: HIS CLIENTS, CARES, AND WORK. By GEORGE RAE, with an American Preface by Brayton Ives. New York: Charles Scribner's Sons. Pp. 320. Price, $1.50.

THIS work, eminently practical in its teachings, presents the results of forty years' experience in banking. Its purpose "is not to formulate afresh the fundamental principles of banking, but rather to show those principles in operation; to exhibit, so to speak, the machinery of banking in motion; . . . less to advance special views of my own, than to exemplify, from fresh points of observation, the accustomed lines and recognized limits of prudent banking." The epistolary form is used—the author taking the position of a person writing instructions to the manager of the bank—because it gives scope to a more familiar treatment of the subject, with such success that Mr. Ives is able to say, in his preface to the American edition, that the book is a notable exception to the admitted rule that the average writer on financial subjects lacks the ability to treat them in an attractive manner. "Without being pedantic, or too

technical, the author has written a book which is so admirable in style that it presents strong claims to public attention, viewed solely from a literary standpoint. . . . The author's experience of thirty-five years in a bank did not convert him into a machine, nor make him unmindful of everything except money-getting. Out of banking hours he must have read many good books, and thought carefully over their contents. We find everywhere signs of his keen knowledge of human nature. He recognizes and demonstrates the fact that successful bankers must have some, at least, of the cardinal virtues; that they must be courteous, honorable, prudent, and industrious."

INDUSTRIAL AND HIGH ART EDUCATION IN THE UNITED STATES. By I. EDWARDS CLARKE. Washington: Government Printing-Office. Pp. 1100.

THIS volume is part of a report on the subject described in the title made by the author to the United States Commissioner of Education. The report complete will include four volumes. The particular branch of the subject here discussed is "Drawing in Public Schools." The object sought in the preparation of the report, as stated by the author, has been to place in the hands of educators and educational officers "the material not only for forming an intelligent judgment upon the advisability of introducing the study of drawing into the public schools, but also, as well, to furnish the facts needed for a like consideration of the questions arising in regard to establishing special schools of technical industrial art training, high art academies, public art museums, art libraries, and of making occasional public loan exhibitions." The volume is in two parts; the report and the appendices, besides an introductory chapter. The report also is in two parts. The first part consists of fourteen "original preliminary papers," occupying 258 pages, "suggesting the direct and indirect relations of art to education, to industry, and to national prosperity," which are grouped under the general heading of "The Democracy of Art." In the second part, of 411 pages, the subject is considered, historically, with respect to England and America (particularly Massachusetts), to the present position of drawing in several States of the Union, and to concurrent contemporary testimony concerning drawing in the public schools. The appendices contain papers relating to early efforts to introduce drawing as a branch of popular education, in the United States and in England; to the origin, development, and purpose of industrial art education; to the management of the Massachusetts State Normal Art School; to the Industrial Art-training Exhibits in the Centennial Exhibition; to Governmental Aid to Education in the Industrial and Fine Arts in Great Britain; to Industrial Education; and to the International Conference on Education, held in London, in August, 1884. The preparation of the report was begun in 1877, or of a part of it, as indicated in one of the statements, as far back as 1874. The work has since been added to several times, but not, apparently, revised; in fact, the author acknowledges that he considered the task of rewriting it a hopeless one, and adopted in preference, as a more feasible plan, "in adding the new matter to leave the history as previously completed, and under the head of 'addenda' to proceed with the subsequent statements." In several instances the "addenda" are far longer than the history to which they are attached. Thus, the report has come to answer, with unusual accuracy, to the author's own description of it as resembling "one of those vast, rambling, mediæval structures to which succeeding ages have builded additions as the needs or tastes of new generations impelled." It contains a great deal of valuable matter, that could have been put, in vastly better shape, in a fraction of the space the present volume occupies. Then we should have had a compact, manageable book, written to the point, which publishers would have competed for the privilege of putting on the market. As it is, it is a striking re-enforcement of our argument against the Government going into the publishing business.

ANNUAL REPORT OF THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION FOR 1885. Middletown. Pp. 139.

THE analysis of commercial fertilizers and work connected with the collection, examination, and valuation of samples have occupied the larger part of the time of the station's working force. One hundred and thirty-nine brands of fertilizers were legally

sold in the State during the year, and one hundred and seventeen other analyses of fertilizers of various kinds were made. Other analyses or tests were made of feeding-stuffs, seeds, milk, well- and spring-water, and soils, and cases of suspected poisoning of animals were inquired into. Four bulletins were published, and sent to the post-offices for distribution to agricultural societies and clubs, to newspapers, and, on application, to private addresses; and hektograph copies of analyses are liberally sent out as soon as the analyses are finished.

OLD SCHOOL DAYS. By AMANDA B. HARRIS. Chicago and Boston: Interstate Publishing Company. Pp. 109, with Plates. Price, 60 cents.

THIS is a vivid reproduction, from memory, of days and scenes and customs that have passed away, and live only in the traditions of those who are now fathers and mothers. It brings before us the New England country school-house of forty or fifty years ago, with the children plainly dressed, and most of them barefooted. The story can not fail to be pleasing to those who would recall the days when they were children, and to those who would enjoy a representation of what their parents did and saw in the school.

THE GREAT CONSPIRACY; ITS ORIGIN AND HISTORY. By JOHN A. LOGAN. New York: A. R. Hart & Co. Pp. 810.

THIS book will attract attention on account of the author's prominence in the politics of the day, and will particularly interest those who recollect his activity as a soldier of the Union during the war of the rebellion. In preparing the book it has been his aim, he says, "to present in it, with historical accuracy, authentic facts; to be fair and impartial in grouping them; and to be true and just in the conclusions necessarily drawn from them. While thus striving to be accurate, fair, and just, he has not thought it his duty to mince words, nor to refrain from 'calling things by their right names'; neither has he sought to curry favor, in any quarter, by fulsome adulation on the one side, nor undue denunciation on the other, either of the living or of the dead"; in treating the subject, "he has conscientiously dealt with it, throughout, in the clear and penetrating light of the voluminous records so readily accessible at the seat of our national government. So far as was practicable, he has endeavored to allow the chief characters in that conspiracy, as well as the Union leaders, . . . to speak for themselves, and thus, while securing their own proper places in history, by a process of self-adjustment, as it were, themselves to write down that history in their own language." Nevertheless, the style of the book is warm; and many of the thoughts and expressions seem more appropriate to a period that survives only in history than to the present, when men's thoughts are running in other channels, and their controversies are on other questions than those that engaged exclusive attention twenty years ago.

SMITHSONIAN ACCOUNTS OF PROGRESS IN 1885. Washington: Government Printing-Office.

GEOGRAPHY. By J. KING GOODRICH. Pp. 36.—Mr. Goodrich has given a very readable account of the year's work in geography, which others than special students of the subject will be interested in. Beginning with "general notes" relating to the condition and growth of geographical knowledge as a whole, he arranges his review under the special headings of the several regions which have been fields of geographical research, with accounts of the work done in each.

CHEMISTRY. By Professor H. CARRINGTON BOLTON. Pp. 50.—This account, though short, gives the record of a busy year's work, in which, while no startling discoveries have been made, a great deal has been done in the study of important questions relative to the nature of the chemical radicals, their relations to one another, and their reactions.

VULCANOLOGY AND SEISMOLOGY. By CHARLES G. ROCKWOOD, Jr. Pp. 23.—The study of this branch is still devoted largely to individual manifestations, with much inquiry for laws and causes, but few definite general conclusions. It is given here as one of the conclusions of Verbeck's investigation of the great Krakatoa eruption, that that volcano lies at the intersection of three fissures of the earth's crust, and the earthquake of September 1, 1880, probably affected the Sunda fissure and facilitated the entrance of great-

er quantities of water to the volcanic furnace beneath. Hence the remote causes of the outburst of 1883.

PHYSICS. By Professor GEORGE F. BARKER. Pp. 60.—Besides the results in general physics, Professor Barker mentions the studies that have been made in the physics of liquids and gases, light, acoustics, and electricity, and special applications.

MINERALOGY. By Professor E. S. DANA. Pp. 26.—The subject is considered under the headings of "General Works on Mineralogy," "Crystallography and Physical Mineralogy," "Chemical Mineralogy," "New Mineral Localities in the United States and elsewhere," and "New Minerals."

ANTHROPOLOGY. By Professor OTIS T. MASON. Pp. 56.—This account includes considerable technical matter; but we find in it sections on the ethnology of the American aborigines, and on the glossology, comparative technology, sociology, and mythology and folk-lore of our tribes.

ASTRONOMY. By WILLIAM C. WINLOCK.—Mr. Winlock works as a substitute for Professor E. S. Holden, whose manuscript review, already prepared, was lost in removing his library. Faye's "Cosmological Theory," and G. H. Darwin's review of it, new discoveries of nebulæ, investigations of astronomical constants, recent star catalogues, studies in parallax, in variable, new, or temporary stars, in stellar spectra, proper motions, and photometry, astronomical photography, what has been done and said about comets, the studies of Langley and others on the sun, and of other astronomers on various planets, receive attention.

ZOÖLOGY. By Professor THEODORE GILL. Pp. 53.—The continued tendency toward the special study of embryology, and of animals from an embryological point of view, is remarked upon. At the same time systematic zoölogy has at least maintained its course. Particular mention is made of Dr. Boulenger's catalogue of the lacertilian reptiles in the British Museum, Professor Cope's "Tertiary Vertebrata," and Professor Marsh's "Dinocerata." The subject is reviewed according to the various groups of the animal kingdom in which memoirs have appeared.

NORTH AMERICAN INVERTEBRATE PALEONTOLOGY. By JOHN BELKNAP MARCOU. Pp. 47.—Mr. Marcou gives summaries of the various monographs that were published during the year, the whole furnishing a fair and tolerably full representation of what was accomplished. All of these reviews, except the "Geography" and the "Paleontology," which is itself a bibliography, add bibliographies of their subjects, and necrological notices. In Professor Gill's zoölogy the bibliographical notices are given in the text according to the groups to which the subjects belong.

PUBLICATIONS RECEIVED.

The Interstate Readers. Primary, pp. 32; Intermediate, pp. 32. Price of each, 40 cents for ten numbers. Grammar-School, pp. 48. 15 cents a number. All monthly, and No. 1, September, 1886. Chicago and Boston: Interstate Publishing Company.

The Irish Question. By the Right Hon. W. E. Gladstone. New York: Charles Scribner's Sons. Pp. 57. 10 cents.

The Relation of Hospitals to Medical Education. By Charles Francis Withington, M. D. Boston: Cupples, Upham, & Co. Pp. 47.

Report of the Iowa Weather Service. 1883. By Dr. Gustavus Hinrichs, Director, Des Moines. Pp. 203.

Bulletin of the Buffalo Society of Natural Sciences. Vol. V, No. 2. Pp. 52, with Plate.

Report of American Association Committee on Indexing Chemical Literature. Pp. 7.

Catalogue of Rutgers College, at New Brunswick, N. J. 1885-'86. Pp. 66.

Function: Its Evolution and Influence. By C. N. Pierce, D. D. S. Philadelphia. Pp. 7.

A New Philosophy of the Sun. By Henry Raymond Rogers, Jamestown, N. Y. Chautauqua Society of History and Natural Science. Pp. 27.

The Manifesto. August, 1886. Henry C. Blinn, editor, Shaker Village, N. H. Pp. 24.

The Silver Question. By E. J. Farmer, Cleveland, Ohio. Pp. 12.

Michigan State Board of Health. Report of Proceedings. July 13, 1886. Pp. 18.

The Botanical Gazette. John M. Coulter, Charles R. Barnes, and J. C. Arthur, editors. Monthly. Crawfordsville, Ind. Pp. 36.

Kupfer in den Vereinigten Staaten (Copper in the United States). By E. Reyer, Vienna, Austria. Pp. 10.

The Menorah. Monthly. Benjamin F. Peixotto, editor. New York: No. 39 Broadway. Pp. 48.

The Hygiene of Nature. By Dr. Romaine J. Curtiss, Joliet, Ill. Pp. 18.

Architecture, Heating, and Ventilation of Institutions for the Blind. By J. F. McElroy, Adrian, Mich. Pp. 21.

Edison's Incandescent Electric Lights for Street Illumination. By A. Hickenloper. Cincinnati: Robert Clarke & Co. Pp. 95. 50 cents.

Duffy's Wave-Motor as a Source of Power, etc. San Francisco: Terence Duffy. Pp. 15.

The Second Law of Thermodynamics. By Professor J. Burkitt Webb. Salem, Mass.: The Salem Press. Pp. 14.

The Heart of the Fish, compared with that of Menobranchus, with Special Reference to Reflex Inhibition and Independent Cardiac Rhythm. By T. Wesley Mills. Montreal. Pp. 11.

C. V. Riley. Report of the Entomologist of the Agricultural Bureau for 1885. Pp. 160, with Plate. The Mulberry Silk-Worm. Pp. 61, with Plate.

The Financial Problem: Its Relation to Labor Reform. By Alfred B. Westrup. Dallas, Texas. Pp. 32.

Ophthalmoscopic Examination of the Insane. By Louis J. Lauterbach, M. D. Philadelphia. Pp. 4.

Exploration of the Marriot Mound, Ohio, No. 1. By C. L. Metz and F. W. Putnam. Pp. 18.

Rutgers Scientific School, New Brunswick, N. J. Twenty-first Annual Report. Pp. 61.

List of Institutions in the United States receiving Publications of the Smithsonian Institution. Washington. Pp. 72.

Resultados del Observatorio Nacional Argentino (Results of the Argentine National Observatory). Juan M. Thome, Director. Buenos Ayres. Pp. 564.

Cassell's National Library. No. 28. Sir Roger de Coverley and the Spectator's Club. No. 29. Voyages and Travels of Marco Polo. No. 30. Merchant of Venice. By William Shakespeare. No. 31. Religio Medici. By Sir Thomas Browne, M. D. Pp. 192 each. 10 cents each.

Practical and Analytical Chemistry. By Henry Trimble. Philadelphia: P. Blakiston, Son, & Co. New York: E. R. Pelton. Pp. 110. $1.50.

The Optimism of Ralph Waldo Emerson. By William F. Dana. Boston: Cupples, Upham, & Co. Pp. 64. 50 cents.

Astronomy by Observation. By Eliza A. Bowen. New York: D. Appleton & Co. Pp. 90, with Plates. $1.

Aphrodite. By Ernst Eckstein. From the German by Mary J. Safford. New York: William S. Gottsberger. Pp. 289.

The Millennial Dawn. Vol. I. The Plan of the Ages. By Charles T. Russell. Pittsburg: Zion's Watch Tower. Pp. 351.

First Lessons in Zoölogy. By A. S. Packard. New York: Henry Holt & Co. Pp. 290. $1.

The First Three Years of Childhood. By Bernard Perez. Chicago: A. N. Marquis & Co. Pp. 292. $1.25.

Hand-Book of Mineralogy. By J. C. Foye. New York: D. Van Nostrand. Pp. 180. 50 cents.

Selections for Written Reproduction. By Edwin R. Shaw. New York: D. Appleton & Co. Pp. 102. $1.

The Jugurthine War of C. Sallustius Crispus. Edited by Charles George Herbermann. New York: D. Appleton & Co. Pp. 272. $1.12.

The Earth's Annular System. By Isaac N. Vail. Cleveland, Ohio: Clark and Zangerle. Pp. 400. $2.

Numbers Applied: A Complete Arithmetic. By Andrew J. Rickoff. New York: D. Appleton & Co. Pp. 416. 75 cents.

Forest Commission of the State of New York. First Annual Report. 1885. Albany. Pp. 362.

United States Commission of Fish and Fisheries. Report for 1883. Pp. 1206, with Plates.

United States Entomological Commission. Fourth Report on the Cotton-Worm and Boll-Worm. By Charles V. Riley. Washington: Government Printing-Office. Pp. 147, with Plates.

Elements of the Comparative Anatomy of Vertebrates. Adapted from Robert Wiedersheim by Dr. W. Newton Parker. London and New York: Macmillan & Co. Pp. 345. $3.

The Logic of Introspection. By the Rev. J. B. Wentworth. New York: Phillips & Hunt. Pp. 446.

Report upon the Third International Geographical Congress and Exhibition at Venice. By Captain George M. Wheeler. Washington: Government Printing-Office. Pp 586.

POPULAR MISCELLANY.

Niagara Falls at the American Association.—Professor Pohlman presented his theory of the origin of the Niagara gorge to the American Association at its recent meeting. This theory differs essentially from the views usually accepted by geologists, that Niagara Falls were originally at Lewiston, and the river has since excavated the chasm through which it flows, thence to the present position of the falls. Professor Pohlman's view is based on a careful survey of the district appertaining to the Niagara basin, which he distinctly defines, with its ancient river-beds, and of the ancient beach-marks on the lake-shores that testify to the gradual subsidence of the water. It supposes that the ancient Tonawanda River flowed into the valley of the present Niagara at about the same place as where it enters now; that the original point of overflow of its waters across the thin-bedded Niagara limestone was perhaps somewhere near or a little southerly from the upper rapids at the present falls; that from here the waters met no obstacle, and in their flow predetermined the river-gorge between the falls and the Whirlpool, and continued in a straight course north through the valley of St. Davis. They descended over the escarpment at the latter place, and along this line in the course of time the three falls over the Medina sandstone and the Clinton and Niagara limestones were formed. During the glacial period the natural drainage-lines were closed up, and a great lake was formed. After the disappearance of the ice-sheet, when the water had subsided to about 605 feet above the ocean, or stood on a level with Lewiston Heights, Lake Erie and Lake Ontario formed two large bodies of water, separated by a mud-flat which extended from Buffalo to Lewiston. Then, as Professor Pohlman attempts to show from the terraces, the two lakes drained simultaneously, and were connected by a river with a more or less swift current, but without any fall, simply deepening its bed in the drift and shaping its course along the buried pre-glacial valleys. But, when the waters reached the Niagara limestone at the edge of the Lewiston escarp-

ment, the current of the river was broken by rapids; for the thin layer of limestone which here overhangs the Niagara shale would barely be strong enough to sustain the tremendous volume of water and form a fall over its edge. The rate at which the gorge was excavated between Lewiston and the Whirlpool must have been rapid. The route was predetermined by a shallow valley, which had reduced the upper layer of limestone to a considerable extent. Thus there was never a fall at Lewiston, only a series of rapids drawing back to the Whirlpool, where the falls were started and whence only, and not from Lewiston, they have receded.

Professor R. S. Woodward, of the United States Geological Survey of the Falls, presented a report on the rate of recession, which he computed to be about 2·4 feet a year, or a mile in 2,300 years. Mr. G. L. Gilbert, also of the United States Geological Survey, gave an account of his observations of the lake-shore terraces, and the conclusions he had drawn from them respecting the subsidence of the lakes. Taking up Professor Woodward's estimate of the rate of recession of the falls, he remarked that it would make the work of excavation extend over 7,000 years. This was subject to various qualifications by channels of earlier origin, by different rocks of different thickness encountered from time to time in the wearing away process, and by the difference in the volume, breadth, and plunge of the river at various periods of its history. On the whole, he was inclined to the opinion that the estimate of 7,000 years should be regarded as a maximum. After one or two other speakers had taken part in the discussion, Professor Pohlman said that he was glad to find the "mountains of science" agreeing with "a mole-hill like himself" regarding the existence of a pre-glacial valley. Professor E. W. Claypole, in a paper on the "What might have been" of Buffalo and Chicago, showed that if the ice-barrier at Buffalo had been twenty-five feet higher than it was, or had the Mackinaw channel been freed from its barrier before the outlet from Lake Erie and Lake Ontario was unlocked, the drainage of the four lakes would have been reversed; the Mississippi would have taken the place of the St. Lawrence, Chicago of Buffalo, and Buffalo of Chicago.

An Æsthetic View of Polygamy.—Mr. George Ticknor Curtis, in his argument in the Supreme Court of the United States in the case of Lorenzo Snow, plaintiff in error, takes a view of Mormon polygamy that we do not remember to have before observed to be insisted upon in the States. By this view the relation to all but a single wife is purely spiritual, and one simply of caretaking, with recollections only of past more intimate ties. The idea of it is given in the testimony of Harriet Snow, who was married to Snow in Nauvoo in 1846, and had never been divorced. She said: "He was not my husband in 1884, according to the general term of husband. He did not live with me as a wife. He had arranged for my support, and I drew it as common. In 1884 I looked upon him as my companion, the husband of my youth. In 1884 the marriage relation did not continue as it was in my young days. I was an old lady in 1884. I call myself a married lady. I was sealed to the defendant for time and for eternity. When a lady gets so that she can not bear children, then she is released from some of her duties as a wife. I mean that he is my companion, but not husband." According to Mr. Curtis's argument, Snow had duties to discharge toward Harriet and the other women similarly situated toward him, which duties, the attorney continues, "are natural, are of moral obligation, of perpetual obligation, and are duties which, when we consider how and when they were assumed, and how they have become woven into the texture of his life, it would be barbaric to punish." The question is, in fact, surrounded with more and greater embarrassments than the urgers of summary legislation to put down polygamy have apparently been ready to consider. The women, who profess to have acted conscientiously, are entitled to protection and provision whatever laws may be enacted. They have a right to be placed where they can be supported and can live respectably. The problem is one of the same kind as that which troubles Christian missionaries when they make converts in polygamous countries,

and which so dignified and able a body as the Convocation of Canterbury has this year substantially confessed itself unable to solve. It is really more complicated than this; for the condition among the Mormons is one that has grown up under our own neglect and tolerance, while we might have met it in the beginning and prevented its development if we had had the nerve to do so.

Inherited Memories.—Dr. H. D. Valin has communicated to "Mind in Nature" (Chicago) some instances in which specific memories appear to have been transmitted by inheritance. He believes that they are the first cases that have been published, for even Ribot confesses to have had but little success in establishing instances of the kind. The most striking case is that of a little girl fifteen months old, the child of a French Canadian father, whose principal traits of character and appearance she seems to have received, and of an American mother of German descent. She has had only the English and German languages spoken to her; yet the first word she ever spoke—when five months old—was *mouman*, the French Canadian form of *maman*, mother. Her first words of assent and dissent were *oui* and *non*—French—when eight months of age, "and she does not yet know *yes* or *ya*, though she seems to have forgotten *oui*. When a year old she was presented with a poodle-dog named Venus, which she called *Nanan*—candy, "one of the very first words that a French child talks." At about the same age she used freely the words *bon*, good, and *pus*, French Canadian for *plus*, no more. These six French words are the very ones that her father is likely to have exclusively used when a babe. The *u* of the last word was sounded as in French, as also were the nasal sounds of *non* and *Nanan*, things which her mother could not have done. Inheritance of memory has been observed in the case of birds, which soon learn to avoid the telegraph-wires, while their young seem equally ready in keeping away from them. Chauncey Wright is quoted as saying of those dreams of strange places and events that often recur to one in his sleep, with the intimation of being familiar though never seen in a wakeful state, that they are inherited memories. Dr. Valin also relates of his own personal experience: "My mother was brought up and educated in a most romantic country village, which she revisited a few months before I was born. The first time I visited it I remembered vividly having been there before. In fact, I could tell at that time what next would follow in the scenery, and I argued with my relatives who were denying my former knowledge of that place; my mother having died when I was about nine months old, and I had not had any description of it from any one, or conversed with any one in regard to the village scenery." A little girl in Burlington, Vermont, with whose family Dr. Valin at one time resided, "had inherited so good a memory of an uncle, whose funeral had been attended by her mother not long before this little girl's birth, that she could give a full description of him, and knew his picture at once the first time that she ever saw it." Some of these cases may have been maternal impressions, but the first one was undoubtedly one of inherited memory.

Alum as a Water-Clarifier.—According to a paper by Professor P. P. Austin, of the New Jersey State Scientific School, extensive use has been made in late years of alum in the processes of purifying water, sewage, etc. It is not improbable, the author says, that, aside from its effect in precipitating matter mechanically by envelopment within the precipitating basic aluminic sulphate, the alum exerts a coagulative action on the albuminous substances in the water, rendering them insoluble, and thus causing their precipitation—perhaps the same or similar effect that alum produces in the tanning of leather. Alum has the great advantage that it is cheap, can be obtained everywhere, and is not highly poisonous. The larger the amount of alum added to the water the more quickly will the separation take place; the smaller the amount added, the longer will the water have to stand before a clarification will be effected. Again, large bodies of water will be precipitated by smaller amounts of alum than one would infer from experiments on a small scale, as the mechanical action of the precipitant here, in enveloping and carrying

down suspended matter, is greater in a large body of water than in a small one. It will be better, however, to err on the side of too large an amount, for even then the amount of alum added will be insufficient to impart any detrimental properties to the water. The water, after precipitation has taken place, is perfectly clear and sparkling, and has acquired neither taste nor smell. For use in the dye-house no possible objection can be made to it.

The Story of India-Ink.—India-ink is of comparatively late introduction in Europe. It was a rarity in the middle of the seventeenth century, and a record exists of a stick of it being preserved along with some "giants' teeth" — mammoth bones—as a curiosity, in the Museo Moscarda, in 1672. The Chinese, however, assign a great antiquity to its use in their country, and name, as the inventor of it, Tien-tchen, who flourished between 2697 and 2597 B. C. About two hundred and fifty years B. C., balls were made of lampblack from fir-wood, lacquer, and size. A poet of that day, singing of this precious material of his art, mentions with especial praise the ink that was made of the firs from the hill-side of Lou-Chan, in the province of Kiang-si. This province was celebrated for the fine quality of its ink, which was at one time made under the supervision of an hereditary government officer as overseer. A number of sticks of the ink were sent every year to the emperor as a tribute. There were illustrious names among the Chinese ink-makers. The most famous of them was Li-ting-Kouei, who not only made his sticks of a quality which has become proverbial, like that of the Stradivarius violins, but molded them into a variety of quaint and artistic forms, and received a special honor from the emperor. During the long history of the Chinese-ink, a great variety of processes have been employed in its manufacture, and nearly every kind of combustible has been used for the production of the lampblack. That resulting from the combustion of petroleum is said to make a more brilliant and blacker ink than that made from fir-wood. The size by which the particles of the lampblack are held together is frequently of animal origin, being made from the bones of the stag, rhinoceros, and ox, and from various kinds of fishes. The Chinese instruments of writing have been assigned supernatural guardians, whose places of precedence are settled by strict rules of etiquette. The "Prefect of the Black Perfume" is the official style of the ink-deity, and he is of higher rank than the divinities of the pencil and the paper. It is said that, a very long time ago, this divinity appeared to the Emperor Hiuan-Tsong while he was writing, and announced to him that henceforth, when a man of true learning or genius should write, the twelve deities of ink should make their appearance to testify to the reality of his powers. It is said that the twelve deities of ink have never appeared since.

Periodicity of Cyclones.—Mr. Charles Meldrum, in continuation of his observations relative to his theory of the periodicity of cyclones, which he believes to occur in cycles corresponding with the eleven-year cycle of sun-spots, has published the results of the meteorological observations which he has systematically compiled from the log-books of vessels traversing the Indian Ocean for the nine years 1876–'84. The observations averaged forty-six for every twenty-four hours included in the review. By the aid of these records nine cyclone-charts have been prepared, one for each of the years, and these, together with the twenty that had previously been prepared for the years 1856–'75, show, as far as has yet been ascertained, the tracks of the cyclones of the Indian Ocean south of the equator in each of the years 1856–'84. The tracks for the years 1848–'55 are nearly ready. With respect to the period 1876–'84, the areas of cyclones and the distances traversed have not yet been determined, but, upon the whole, the number and duration of the cyclones decreased to a minimum in 1880, and then increased till, in 1884, they were more than double what they were in 1880. From the accompanying track-charts for the eleven years, 1856, 1857, 1860, 1861, 1867, 1868, 1871, 1872, 1879, 1880, and 1884, it appears that the number and duration of the cyclones of 1856 and 1857 were much less than those of the cyclones of 1860 and 1861;

that those of 1867 and 1868 were much less than those of 1860 and 1861, on the one hand, and of 1871 and 1872 on the other; and that the number and duration of the cyclones of 1879 and 1880 were much less than those of the cyclones of 1871, 1872, and 1884; but it appears that in 1884 there was less cyclone activity than in 1861 and 1872.

Antiseptics and Disinfectants. — The Committee on Disinfectants of the American Public Health Association calls attention in its report to a distinction which is not always accurately enough observed between disinfectants—substances which destroy germs—and simple antiseptics—which prevent their development. Many of the preparations put on the market as disinfectants are in reality only antiseptics. While practically the words disinfectant, in its strict sense, and germicide, are considered to mean the same thing, so long as it is not proved that all infections are developed from germs, we must regard "disinfectant" as a word of more general significance than germicide. But, as a matter of fact, those agents which by laboratory experiments have been proved to be the most potent germicides have also been shown to be the most reliable disinfectants. While antiseptic agents may fail to fulfill the stronger purpose of disinfectants, they are known to exercise a restraining influence on the development of disease-germs, and their use during epidemics is recommended, when masses of organic material in the vicinity of human habitations can not be completely destroyed or removed, or disinfected. A substance of this kind is sulphate of iron, or copperas, which, while it does not destroy the vitality of disease-germs or the infecting power of material containing them, is a very valuable antiseptic, the low price of which makes it one of the most available agents for the arrest of putrefactive decomposition. While an antiseptic agent is not necessarily a disinfectant, all disinfectants are antiseptics; for putrefactive decomposition is due to the development of germs of the same class as that to which disease-germs belong, and the agents which destroy the latter also destroy the bacteria of putrefaction when brought in contact with them in sufficient quantity, or restrain their development when present in smaller amounts. Antiseptics are a poor substitute for cleanliness.

Wind-Carving in Maine.—Mr. George H. Stone discusses, in the "American Journal of Science," some instances of wind-action on till and bowlders which he has observed in Maine. One of the features of the surface geology of this State is the large areas of sand which were deposited by most of the rivers along the lower part of their courses during the Champlain epoch. The valley of the Androscoggin is particularly distinguished by its sand-dunes. Not rarely spots bare of vegetation can be found on hill-sides exposed to high winds, where, during dry days, the wind removes the finer parts of the till and drives the gravel back and forth just as happens in Colorado during the dry winter weather. The effects of this process are, however, usually obliterated or obscured by the frequent rains and abundant snows; but the wearing marks of the action are plainly observable in many cases, as on the top of a hill near Wayne village. At Bethel are found bowlders which exhibit on one or more of their surfaces grooves, scratches, striæ, and polishings, the origin of which was for a long time problematical; and similarly marked stones have been noticed at Gilead and in Gorham, New Hampshire, all near the Androscoggin River. Mr. Stone believes that he solved the mystery of these marks during his investigation of the glacial gravels of the region in the summer of 1885. In numerous places, at Bethel and elsewhere, he found "bowlders and even small stones which are now being sand-carved by the wind as plainly and incontestably as in Colorado. The drifting dunes of fine sand do not produce this effect to any great extent, probably because the stones are covered and uncovered too rapidly. But there are bare spots not protected by grass where coarse sand and gravel are driven back and forth by the wind, and here the carved bowlders can be seen in considerable numbers and in all stages of the process. In some cases it appeared probable that these bare places were where drifting sand had swept over the surface and the till had been partially denuded by

the wind. . . . Every feature of the Bethel bowlders under consideration is fully accounted for by the hypothesis of sand-sculpturing under the action of the wind." An accessible locality for observing this action is found about a mile from West Bethel, on the east side of the road leading to Mason.

Should Children go barefooted?—The "Lancet" gives a decided affirmative answer to the question, "May children go barefoot without injury?" It holds that, on physiological grounds, it is manifestly a sound practice to accustom children to develop the circulatory and muscular systems of the lower extremities, as those of the hand are developed, by free use and exposure. No one thinks a child ought to be protected from the weather, so far as its hands are concerned, but it is recognized that the upper extremities should be kept warm by exercise and habitual exposure. The bones and vessels need freedom for development; and if the blood-vessels of the foot and leg are fully developed, as they can be only when the foot is habitually exposed, the quantity of blood which the lower extremities can be made to receive, and if need be attract for a time, is very considerable. Children who are allowed to go barefooted enjoy almost perfect immunity from the danger of "cold" by accidental chilling of the feet, and they are altogether healthier and happier than those who go about with their feet done up. For the poorer classes of children, "it is incomparably better that they should go barefooted than wear boots that let in the wet and stockings that are nearly always damp and foul."

Development of Fleas.—Mr. George Harkus has succeeded in observing the whole process of the development of the flea from the laying of the egg up. He undertook to begin his experiment with two egg-laden females in a box, but the only result was a fierce battle that compelled separation of the two at once. Each individual laid a batch of from three to twenty-four eggs—the average was about a dozen—white and oval. Each end of the ova appeared through the glass surrounded by a spiral whorl of oval punctures, eighty at one end and forty at the other. The eggs were so nearly transparent that the whole process of development could be easily watched, and the exhibition, to judge from the warm terms in which it is described, must have been extremely interesting. The larvæ resembled elongated little worms, were destitute of feet, and kept up the usual wriggling motion of their kind. They absolutely refused to be fed, and usually died in a few days, so that very few chrysalides were obtained. Perhaps, if they had been given their natural way of feeding, whatever that may be, the success might have been better. Any exposure to cold or damp was immediately fatal. The larvæ, as the pupa stage is approached, assume a red hue, and, about eight days from hatching, spin a cocoon like a fluffy speck of white cotton. The threads are closely woven and of extreme tenuity, and, when attached to a textile material of similar color, must be very difficult of detection. A cocoon was opened after the inmate had divested itself of the pupa-case, but still remained enveloped in a filmy transparent integument. This pellicle covered the insect completely, following each leg and antenna continuously. "About four weeks is required to metamorphose the speck of vitalized matter contained in the minute ovum of *Pulex irritans* into a suctorial tormentor."

Science in Japan.—A wise step was taken when the University of Tokio and the Engineering College were merged into one organization. This institution, now called the Imperial University of Japan, comprises five colleges, representing the departments of law, medicine, engineering, literature, and science. Each of these colleges has its special director. The College of Science is showing great activity in biological work. Mr. Ishikawa, who recently graduated, is now in Freiburg, studying under Weissmann. Mr. Matsumura, the assistant professor of botany, is in Wurzburg, under Sachs. A marine laboratory is to be built at Misaki, Sagami. Mr. Tsuboi, a student who graduates this year, is to study anthropology as a specialty. A new journal is to be established by the College of Science, from which we infer that the memoirs of the University of Tokio will be discontinued. The first num-

ber of the new journal will contain a memoir by Professor Sasaki on the development of the maggot parasite in the silk-worm. The government awarded Professor Sasaki a gift last year in recognition of his admirable discoveries concerning the diseases of silk-worms. The Tokio Anthropological Society, although recently organized, is doing excellent work. It has already issued five numbers of its journal, each one illustrated by lithographic plates. We wish, for the benefit of foreign readers, it would give a brief synopsis in English of the contents of each number. Mr. Iijima, who studied with Leuckart in Leipsic, and took the gold medal over all the German students for the best thesis, is again in his native land and working in the laboratory of the college. E. S. M.

The Lengthening of Human Life.—The "Lancet," apparently accepting the general opinion that the maximum age attainable by man has risen somewhat during the present century, observes that the line of seventy years is now very frequently passed, that many reach fourscore "without excessive labor and sorrow," and that "we have among us nonagenarians who carry on with still respectable proficiency the activities of their prime. Such effective longevity is a bright spot in the history of our advancing civilization. Its comparative frequency and its association with different physical types suggest a certain generality in its origin, and encourage the hope that it may be, in some measure at least, dependent on personal conduct." After middle age, however, not personal conduct, but inherited vital force, is a potential factor, although it is not an exclusive one. Disposition may have great influence upon vitality; "and there can be no doubt," says the "Lancet," "in our opinion, that there is much room for exercise of private judgment and energy in seeking the prolongation of one's own life." It is not to be believed "that man is unable so to adjust his circumstances to his needs as to continue to live after a certain mean period. The weaker will sometimes prove himself the more tenacious of life by observing rational methods of living of which the more robust is careless. Moderation has probably more to do with success in this respect than anything else. To eat sufficiently, and drink stimulants sparingly, to alternate work with adequate rest, and to meet worries heartily, will afford every one the best chance of arriving at a ripe old age."

Premonitions of Inebriety.—Dr. T. D. Crothers, of Walnut Lodge, Hartford, Connecticut, having studied "the incipient stages in inebriety," endeavors to show that the oncoming of the disease, as he regards it, may be foreseen, and that preventives and curative measures applied at that time give more promise of certain results than at any other period. Sometimes premonitions of inebriety reveal themselves in the dispositions of the subject before any spirits have been used by him; when they may be marked by dietetic delusions and other symptoms of nerve and brain irritability, which seem to depend on heredity or some obscure injury to the nerve and brain centers. He believes that the recognition and study of this stage opens up a field of prevention and cure that will attract great attention at an early day.

Signal Stations at Sea.—Mr. F. A. Cloudman, of Rondout, New York, has projected a plan for the establishment of ocean-signals, light-ships, and life-saving stations at sea. His system embraces a strongly constructed cylindrical vessel, with a convex upper deck, moored at such a depth of submergence as will give it the greatest attainable stability, by means of cables and anchors fixed in the bottom of the ocean. From the top of this structure arises a skeleton framework, to sustain a brilliant electric arc-light, with Fresnel lenses, a powerful steam-siren, and ventilating, smoke, and steam pipes. The interior of the vessel is to be divided into several decks or holds, to be used as cabins, offices, operating and apparatus rooms, etc. An ocean-cable is to be run from shore to shore, looping in at each of the stations. For deep-sea service, the stations should be placed at maximum distances of five hundred miles from one another. For coast service, they should be placed at or near dangerous shoals, reefs, etc., and connected by telegraph cable with the mainland.

NOTES.

THE American Association, at its recent Buffalo meeting, chose Professor S. P. Langley as its president for the year. The vice-presidents or presidents of sections elected are: Mathematics and Astronomy, William Ferrell; Physics, William A. Anthony; Chemistry, Albert B. Prescott; Mechanical Science and Engineering, Eckley B. Coxe; Geology and Geography, G. K. Gilbert; Biology, W. G. Farlow; Anthropology, D. G. Brinton; Economic Science and Statistics, Henry E. Alford. Permanent secretary, F. W. Putnam; general secretary, W. H. Pettee; assistant general secretary, J. C. Arthur; treasurer, William Lilly. The place for the next meeting was not decided upon.

THE "Botanical Gazette" says: "'The Popular Science Monthly' for June contains a portrait and biographical sketch of the late Dr. George Engelmann. The author is anonymous, but can hardly have been a botanist, or he would not be so ignorant of the true authorship of the classic 'Plantæ Fendlerianæ' as to say, 'In 1849 Dr. Engelmann published in the "Memoranda [*sic*] of the American Academy of Arts and Sciences" the "Plantæ Fendlerianæ."' He infelicitously adds, regarding Fendler: 'Fendler and he [Engelmann] had become acquainted on a governmental expedition to the Rocky Mountains, to which the former was attached as engineer. . . . He traveled in the Rocky Mountains, California, Mexico, Central America, and Brazil.' Fendler did not become acquainted with Engelmann in this way; he was never attached officially to any governmental expedition; he was not an engineer; and he traveled neither in the Rocky Mountains, nor California, nor Mexico, nor Central America, nor Brazil!"

Our sketch of Dr. Engelmann was prepared from documents furnished us by his friends in St. Louis. The statements to which the "Gazette" objects are given precisely as they appeared in one of the papers. As the "Gazette" has recently published Fendler's autobiography, it is probably in a position to be better informed, respecting the events of his life, than is the biographer of another man who only had occasion to refer to them incidentally. We are glad to be set right on the facts.

PROFESSOR L. E. HICKS, in one of the papers which he read at the American Association on the geology of Nebraska, spoke of the strong artesian flow of water contained in all the borings of the eastern part of the State. This is because the region is a vast synclinal trough or basin, of which the western rim is three thousand feet higher than the eastern.

PROFESSOR ASA GRAY sent two communications of a technical character to the American Association, and with them a letter to the Botanical Club, respecting his nomenclature of violets. He makes out thirty-three wild North American species of these plants, of which only eight are represented in the Old World. He acknowledges himself to be in doubt whether our pansy violet is indigenous to this country.

MR. JOSEPH JASTROW read a paper before the American Association on centenarianism, in which he made an elaborate calculation of the proportion of cases in which claims to this distinction should be eliminated for want of trustworthy evidence, or as based on exaggeration. Removing these, he concluded that there were about fifty centenarians in the United States. Some of his conclusions were disputed; but he is said to have, in the discussions that followed, shown himself to be well fortified.

THE statistical reports of the American Association show that it has doubled its membership within the last twenty years. Two hundred and fifty-two papers were read at the recent Buffalo meeting, against one hundred and seventy in 1876, and sixty-seven in 1866.

"THEISM" is the somewhat awkward and confusing name given to a class of diseases that arise from the wrong use of tea. The predominance of nervous symptoms is a characteristic of the condition; and it may be observed in a general excitation of the nervous function, or in special weakness of the brain. Perversion of the sense of hearing is a not uncommon form of the symptoms. The weakness that often overtakes women may sometimes be traced to excessive indulgence in their favorite drink. Taken in strict moderation, and prepared with proper care, tea is a valuable stimulant; but there is hardly a morbid symptom that it is not capable, when used in excess, of producing.

THE American Association designated Dr. Pohlman, of Buffalo, who had served as its local secretary, as its representative at the meeting of German Naturalists and Physicians. This will be its first formal representation before that body.

ACCORDING to M. Mantegazza, 64 per cent of the Italians have chestnut, 22 per cent black, 11 per cent blue, and 3 per cent gray, eyes; 71 per cent of them have chestnut, 26 per cent black, and 3 per cent blonde hair. More than three fourths of the people have abundant hair. Southern Italy excels Northern Italy in this respect. In Tuscany the poor heads of hair preponderate (58 against 42 per cent), and baldness is most common there. The color of the beards

does not always correspond with that of the locks. Generally, of ten thousand young men examined for military service, twenty were rejected for premature baldness, and fifty-two for diseases of the scalp. A few cases of red hair are found, and in one commune this color is predominant. The origin of this colored hair is a subject of discussion. Some think it has come down from an almost extinct race; others that it is a mere physiological accident, from which no conclusion can be drawn.

THE English National Fish Culture Association reports that its last year's growth of newly hatched salmon was six and a half inches, and of white-fish five inches.

MR. BLANFORD, meteorological reporter to the Government of India, is testing from year to year a theory of a connection between the Himalayan snow-fall and the monsoon, to the effect that the later and heavier the snow-fall in winter and spring, the later and feebler would be the following monsoon. The forecasts according to his theory were fairly accurate last year. This year they appear favorable to a prompt monsoon and abundance of rain.

A SWEDISH naturalist remarks upon the frequency with which names derived from natural history are adopted by the nobility of his country. Lion, eagle, tiger, wolf, and bear, and even mythical animals like the griffin and the dragon, have furnished several families with parts of their names. Most of the domestic animals are also represented, and plants, such as the lily, rose, laurel, cedar, oak, and lime, are still more fully represented. Numerous stars form the prefix of names, but in no case the sun or moon. The word *stjerna*, star, is used both at the beginning and at the end of names; but the *stjerna* in Oxenstjerna does not represent this word, but the German *Stirn*, forehead.

M. BLANCHARD conceives that the recent seismic catastrophe in New Zealand lends probability to his theory that that island is one of the remnants of a formerly existing Australian continent that has been submerged. Evidence was wanted of the liability, present or past, of the regions to shocks severe enough to suggest that former stronger shocks might have produced such phenomena of submergence as he predicates. The late shock was one of the kind.

MM. CAILLETET and Mathias have reported to the French Academy of Sciences concerning their researches on the density of the liquefied gases—in the cases of protoxide of nitrogen, ethylene, and carbonic acid, that at the critical point the density of the liquid gas is equal to that of its vapor.

THE number of births in France per ten thousand inhabitants has diminished more than one third in a century. It was 380 in 1771–'80, 289 in 1831–'40, and only 241 in 1871–'80.

MR. ALFRED BENNETT has given an interesting account of the egg-laying and hatching habits of the emu. The hen-bird lays her brood of twenty eggs or more, at intervals of two days, during about six weeks in October and November. Before the process is completed, the cock-bird begins to sit. The eggs laid subsequently are deposited by the hen by the side of her mate, who puts out his foot and draws them under him. As soon as the eggs begin to hatch it is necessary to isolate the hen, because she fights furiously with her mate and seems disposed to kill the chicks if she could get at them. The whole of the tending of the young is performed by the male bird.

THE first case of the admission of a woman to the French Academy of Sciences occurred on the 28th of June, when Sophie Kowlewska, Professor of Mathematics at the University of Stockholm, and daughter of the eminent paleontologist, was received as a member. Admiral Jurien de la Gravière, President of the Academy, made her a graceful address of welcome, and she took her seat between General Fave and M. Chevreul.

MICLUCHO MACLAY, the explorer of New Guinea and the neighboring islands, has brought with him to Odessa, Russia, a large collection of objects illustrating the qualities of scientific interest in the countries in which he has traveled.

OBITUARY NOTES.

MR. GERRARD KINAHAN, son of the Irish geologist, who had connected himself with an African trading company, was killed by a poisoned arrow in a fight with the native tribes at Anyappa, May 23d. His training as a chemist and geologist at scientific schools in Dublin and London had thoroughly qualified him for scientific research, and there is no doubt that had he lived he would have added much of value to our knowledge of Africa.

THE death is announced of Mr. George Busk, F. R. S., a well-known English surgeon and naturalist, in the seventy-eighth year of his age.

DR. R. J. MANN, who was for three years President of the English Meteorological Society, has recently died. He was a popular and prolific writer, and gave much attention to the subject of the protection of buildings from lightning. He was for several years head of the education department and medical officer in the colony of Natal.

INDEX.

PAGE

Abysses, the Oceanic, Condition of 715
Agrarian Agitation, A Canadian Chapter in 462
Air, Sea, and Mountain 141
Alum as a Water-Clarifier 858
Animal Diseases, The Microbes of 761
Animals, What may, be taught 168
Antarctic, The, Ocean 660
Antiseptics and Disinfectants 860
Arbitration and Conciliation, New Light on 567
Architecture, Evolution in 642
Armsby, Professor H. P 831
Ashley, Charles S 721
Association, the American, The Buffalo Meeting of 844
Astronomical Work, Dr. Gould's, The Magnitude of 280

Bacteria under High Pressure 140
Baker, Francis H 642
Balloon, Travel by 428
Barefooted? Should Children go 861
Benedict, Professor W. R 626, 747
Bergen, Mrs. F. D 867
Bienenfeld, Bernard 124
Birds, The Flying Force of 427
Birds, the, Protect 281
Black and White, Are, Colors? 814
Blackfoot Tribes, the, Ethnology of 204
Bohemian Glass 346
Bolton, Professor H. C 523
Books noticed:
"Three Years of Arctic Service" (Greely) 127
"Easy Lessons in German" (Dreyspring) 129
"The Determination of Rock-forming Minerals" (Hussak and Smith). 129
"History of the Pacific States" (Bancroft) 130
"Practical and Analytical Chemistry" (Trimble) 130
"Evolution of To-Day" (Conn) 131
"The Sun" (Guillemin and Phipson) 131
"History of California" (Hittell) 132

Books noticed:

PAGE
"A Text-Book of Inorganic Chemistry" (Von Richter and Smith).... 132
"Ventilation of Buildings" (Butler)..... 133
"Water-Meters" (Browne)..... 133
"Mechanical Integrators" (Shaw)..... 133
"Preservation of Timber by Antiseptics" (Boulton)..... 133
"Chemical Analysis" (Scott-White)..... 133
"First Lessons in Philosophy" (Handley)..... 133
"Chemical Equilibrium the Result of the Dissipation of Energy" (Liveing)..... 134
"Moisture and Dryness" (Denison)..... 134
"Comparative Literature" (Posnett)..... 269
"Hunting Trips of a Ranchman" (Roosevelt)..... 270
"Influence of Sewerage and Water-Supply on the Death-Rate in Cities" (Smith)..... 272
"The Epic Songs of Russia" (Hapgood)..... 273
"Applied Geology" (Williams)..... 273
"Fifth Annual Report of the United States Geological Survey" (Powell)..... 275
"Gyrating Bodies" (Warring)..... 275
"American Diplomacy" (Schuyler)..... 275
"Dutch Village Communities on the Hudson River" (Elting)..... 276
"Town Government in Rhode Island" (Foster)..... 276
"The Narragansett Planters" (Channing)..... 276
"Pennsylvania Boroughs" (Holcomb)..... 276
"Proceedings of the American Society of Microscopists," 1885..... 277
"Studies in General History" (Sheldon)..... 277
"Injurious and other Insects in New York" (Lintner)..... 277
"Upland and Meadow" (Abbott)..... 415
"Flowers, Fruits, and Leaves" (Lubbock)..... 416
"Popular Government" (Maine)..... 416
"Oceana" (Froude)..... 417
"The Adirondacks as a Health Resort" (Stickler)..... 418
"What does History teach?" (Blackie)..... 418
"Transactions of the Anthropological Society of Washington"..... 418
"Essays on Educational Reformers" (Quick)..... 419
"The Late Mrs. Null" (Stockton)..... 419
"Hobbes" (Robertson)..... 419
"Appalachia"..... 420
"Appalachian Mountain Club Register"..... 420
"Bulletin of the United States Fish Commission," 1885..... 420
"The Order of Creation" (Gladstone, Huxley, and others)..... 420
"Wonders of European Art" (Viardot)..... 421
"Elements of Universal History" (Cottinger)..... 421
"Scriptures, Hebrew and Christian" (Bartlett and Peters)..... 421
"The Story of Chaldea" (Ragozin)..... 421
"Did Reis invent a Speaking Telephone?" (Dolbear)..... 421
"On Telephone Systems" (Dolbear)..... 421
"Notes on Certain Maya and Mexican Manuscripts" (Thomas)..... 422
"Railroad Terminal Facilities at New York" (Mordecai)..... 422
"Artesian Wells" (Chamberlin)..... 422

Books noticed: PAGE
"Commissioner of Education, Report for 1883–'84" 422
"A Manual of Mechanics" (Goodeve) 422
"Evolution" (Deems) 423
"The Choice of Books" (Harrison) 423
"Poetry as a Representative Art" (Raymond) 423
"The Fisheries and Fishing Industries of the United States" (Goode). 423
"Teacher's Hand-Book of Psychology" (Sully) 556
"Triumphant Democracy" (Carnegie) 558
"California" (Royce) 559
"Food Materials and their Adulterations" (Richards) 559
"Scientific Laboratories of Denison University" (Herrick) 560
"Food Consumption" (Wright and Atwater) 560
"Hand-Book of Plant Dissection" (Arthur, Barnes, and Coulter) 560
"Protection or Free Trade" (George) 561
"Industrial Depressions," Report of Commissioner of Labor on (Wright) 561
"Socialism and Christianity" (Behrends) 562
"Political Science Quarterly" 562
"Persia" (Bassett) 562
"Outlines of Geology" (Geikie) 563
"Class-Book of Geology" (Geikie) 563
"The Wealth of Households" (Dawson) 564
"Manual Training" (Horn) 564
"Color-Studies" (Janvier) 564
"Astronomy during the Nineteenth Century" (Clerke) 564
"Forests and Fruit-Growers" (Kinney) 565
"Circulars of Information of the Bureau of Education" (Technical Instruction and Education in Japan) 1885 565
"Monthly Catalogue of Government Publications" (Hickox) 565
"Life and Genius of Goethe" (Sanborn) 565
"An Apache Campaign in the Sierra Nevada" (Bourke) 566
"John Cabot's Landfall and Norumbega" (Horsford) 566
"Smithsonian Report for 1884" 566
"Elements of Economics" (Macleod) 700
"Colorado Scientific Society Proceedings" 701
"Psychology" (McCosh) 702
"Manual Training" (Ham) 703
"Contributions to the Tertiary Geology and Paleontology of the United States" (Heilprin) 704
"Annual Address" (Riley) 704
"Climatic Treatment of Disease" (Marcy) 704
"Kant's Ethics" (Porter) 705
"The Economical Fact-Book" (Bowker) 705
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"Davenport Academy of Sciences, Proceedings" 706
"On Small Differences of Sensation" (Peirce and Jastrow) 707

Books noticed:
PAGE
"Diseases of thee Nrvous System" (Hammond)..... 707
"History of the Sabbath and Sunday" (Lewis)..... 707
"Medicine of the Future" (Flint)..... 708
"Life" (Wilder)..... 708
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"Report of the Connecticut Agricultural Experiment Station," 1885..... 853
"Old School Days" (Harris)..... 854
"The Great Conspiracy" (Logan)..... 854
"Smithsonian Accounts of Progress in 1885"..... 854
Bottoms, Deep-Lake, Fauna of..... 717
Box-Wood, A New Species of..... 430
Brain, The Care of the..... 386
Brooks, Margarette W..... 317
Brooks, Professor W. K..... 806
Butler, Professor N. M..... 482

Camphor, Japanese..... 280
Cancer, Origin of..... 569
Carbonic Acid, Use of Liquid..... 428
Carpets, Oriental..... 572
Champion, A Pony..... 142
Charity and Sentimentality..... 125
Chemistry, Recent Progress in..... 523
Chicago, The, Public Schools..... 425
Children, Animal and Plant Lore of..... 367, 842
Children, Should, go barefooted?..... 861
Chorea, School-Life and..... 717
Christie, W. H. M..... 795
Church, The, and State Education..... 554
Climate, Geological, in High Latitudes..... 352

PAGE
Clocks, Primitive 180
Coal-Waste as a Manure 712
Coan, Titus M., M. D. 508
Coast, the New England, Glacial Elevations of 135
Commercial Crisis, the Present, Causes of 491
Cooking Apparatus, A New Hot-Water 571
Colors? Are Black and White 814
Coral Island, Life on a 806
Correspondence 122, 411, 841
Counting unconsciously 221
Cray-Fish, Some Peculiar Habits of the 784
Crime, Education and 570
Crystallization, The Problem of 46
Cyclone, Autobiography of an Ancient 573
Cyclones, Periodicity of 859

Daubrée, M. A. 374
Dawson, Joseph 75
De Candolle on the Production of Men of Science 34
Delbœuf, M. J. 168
Diet, The Philosophy of 818
Domestic Fireplace Construction, The Principles of 230
Don't 268
Doty, Harry Austin 814
Dudley, P. M., C. E. 433, 604

Earth-Contraction and Mountains 283
Earthquakes and other Seismic Movements 305
Earthquakes in China 571
Earthquake-Vibrations, Variation in 286
Eaton, Virgil G. 803
Economic Association, The American 426
Editor's Table 125, 266, 412, 554, 698, 842
Education and Crime 570
Education, Some Outlines from the History of 626, 747
Eels and their Young 254
Einhorn, Alfred 46
Elements, New Chemical 714
Engelmann, George, M. D., Sketch of 260
Ethnology of the Blackfoot Tribes 204
Evolution bounded by Theology 145
Evolution in Architecture 642
Evolution, Organic, The Factors of 54, 192
Exercise, The Influence of, upon Health 322
Exercise, The Physiology of 841
Extinction of Species, the, Causes of 429
Eyes, Swedish, Colors of 428

Fear, A Psychological Study of 771
Financial Stringency, Causes of 285

PAGE
Fire-Extinguishers, Automatic 137
Fishes and Frogs, Parental Peculiarities in 136
Fish, Fossil, in New Jersey Trias 574
Flat-Fish, The Science of 107
Fleas, Development of 861
Flying-Fish, Does the, fly? 122
Flying Force, The, of Birds 427
Food Accessories and Digestion 63
Food, Poisons formed from 284
Forest Devastation in Japan 714
Forest Preservation, Canadian 141
Fouillée, Alfred 681
France, Eastern, Mineral Springs of 508
Fraud and its Victims 842
Fungi, Parasitic, on Plants 138
Future, A Bald and Toothless 803

Galton, Francis, Sketch of 117
Gaudry, Albert 827
Genesis, The Interpretation of 122
Genius and Precocity 469, 594
German Paleontological Museums 827
Gillmore, Parker 617
Gould's (Dr.) Astronomical Work, The Magnitude of 280
Government, the Federal, Transportation and 335

Hadley, Arthur T 1
Hale, Horatio 204
Hamerton, Philip Gilbert 83
Heat, A New Prospective Source of 140
Heavens, the, Photographing 71
Heer, Oswald, Sketch of 546
Hereditary Diseases and Race-Culture 639
Holder, C. F 784
Horse-Eating 711
House Sanitation, Ancient 140
Hovelacque, M. A 98
Huxley, Professor T. H 458

Ice, What, can do 282
Iles, George 462
India-Ink, The Story of 859
Indian Medicine 649
Inebriety, Premonitions of 862
Inherited Memories 858
Insect Species, an, Distribution of 428
Inventions, The Genesis of 136
Iron, Rustless 393
Irrawaddy, The Problem of the 427
Irrawaddy, The River 712

PAGE
James, Joseph F..... 660
Japan, Forest Devastation in..... 714
Japan, Science in..... 861
Jordan, Professor David Starr..... 212

King-Crab, The, in New Waters..... 569
Kinley, Isaac..... 122
Klein, Dr. H. Y..... 71

Laboratory, The Physical, in Modern Education..... 504
Labor Troubles..... 266
Language, The Evolution of..... 98
Larrabee, W. H..... 34
Le Play's Studies in Social Phenomena..... 787
Leroy-Beaulieu, Paul..... 491
Le Sueur, W. D..... 145, 577
Lick Observatory, the, Advantages of..... 710
Life, Human, The Lengthening of..... 862
Life on a Coral Island..... 806
Lion Country, In the..... 617
Literary Notices..... 127, 269, 415, 556, 700, 845
Liquorice, Cultivation of..... 715
Liquors, How Alcoholic, are made..... 75
Lockwood, Professor S..... 245
Lore, Animal and Plant, of Children..... 367, 842

Madness, The Millennium of..... 226
Mange, P. F..... 411
Mather, Frederic G..... 180
Medicine, Indian..... 649
Memories, Inherited..... 858
Mercator, Gerard, Sketch of..... 404
Metal, The Coming..... 713
Meteorites, Meteors, and Shooting-Stars..... 733
Meteorites, The Origin and Structure of..... 374
Mexico, An Economic Study of..... 11, 153, 289, 411, 444
" Note on..... 556
Microbes, The, of Animal Diseases..... 761
Minerals, The Development of..... 397
Moral Faculty, The Development of..... 29
Moral Teaching in Public Schools..... 698
Mountains, Earth-Contraction and..... 283
Museums, Paleontological, German..... 827

Natural Phenomena, The Prediction of..... 538
Nature, Some Economics of..... 666
Neith, The Hypothetical Planet..... 285
New Chemical Elements..... 714
Newton, General John, Sketch of..... 834

PAGE
Newton, Professor Hubert A. ... 733
Niagara Falls at the American Association ... 856
Nineteenth Century Club, The ... 567
Nitrification ... 831
Notes ... 142, 287, 431, 574, 718, 863
Nuisance, A Bee ... 139

Ocean, The Antarctic ... 660
Oswald, Felix L., M. D ... 226
Outlines, Some, from the History of Education ... 626, 747
Oyster, How the, makes his Shell ... 279

Parsee Children ... 568
Parsee Funerals ... 426
Phenomenon, A Curious Optical ... 841
Philosophy, The, of Diet ... 818
Photographing the Heavens ... 71
Pictures and Prints, The Care of ... 83
Planet, The Hypothetical, Neith ... 285
Pleasure and Pain, The Nature of ... 681
Poisons formed from Food ... 284
Poisons, The, in Spoiling Food ... 250
Polygamy, An Æsthetic View of ... 857
Popular Miscellany ... 135, 279, 425, 567, 710, 856
Porter, Ex-President, on Evolution ... 577
Preston, Dr. G. J ... 689
Preyer, Professor W ... 221
Protect the Birds ... 281
Psychical Research, The Progress of ... 482
Psychology as a Science ... 699
Punjab, The ... 138
Putnam, Frederick Ward, Sketch of ... 693

Race-Culture, Hereditary Diseases and ... 689
Rafinesque ... 212
Railroad Regulation, The Difficulties of ... 1
Ranney, Professor Ambrose L., M. D ... 386
Richards, Professor E. L ... 322
Richet, Charles ... 771
Rivers, Underground ... 716
Rosenberry, A. B., M. D ... 841
Rowland, Professor Henry A., Ph. D ... 504
Rustless Iron ... 393

Schafft, Dr. A ... 538
School-Life and Chorea ... 717
Schwarz, Professor Heinrich ... 346
Science and the State ... 412
Science, De Candolle on the Production of Men of ... 84

PAGE
Science in Japan 861
Scratching in the Animal Kingdom 245
Sea-Bathing, Principles of 426
Sea-Voyages, Advantages of 716
Sharpless, Professor Isaac 519
Shooting-Stars, Meteorites, Meteors, and 733
Silk-Culture, An Experiment in 317
Silk-Culture, The "Profits" of 568
Snails, American, Life-History of 573
Snake-Poison, Antidotes for 124
Snake-Poisoning 283
Social Phenomena, Le Play's Studies in 787
Solar Heat, Influence of Direct, on Vegetation 139
Soles and Turbot 107
Somauli-Land, Incidents of Travel in 713
Somaulies, Traits of the 570
Spectroscope, The, and the Elements 430
Spencer, Herbert 54, 192
Springs, Mineral, of Eastern France 508
Stations, Signal, at Sea 862
Stinde, Julius 250
Stockwell, G. Archie, M. D 649
Storms, Cuban 430
Stringency, Financial, Causes of 285
Sully, James 29, 469, 594
Swallows, Intelligence of 142
Swamps, draining, Have we gone too far in 282

Teaching, Scientific, The Extension of 458
Tea-Drinking, is, Salutary? 286
Teale, T. Pidgin, F. R. C. S 230
Telephone, Professor Pickering's 281
Tenant-Farmers, Happy 137
Thomas, B. F 841
Thoulet, M. J 397
Time, Good, and its Ascertainment 519
Time, Universal 795
Toad-Lore 429
Transportation and the Federal Government 335
Trap-Dike, The, of Southeastern Pennsylvania 279
Trias, New Jersey, Fossil Fish in 574
Trouessart, E. L 761
Turquoises 284

Universal Time 795

Vegetation, Influence of Direct Solar Heat on 139

Warner, A. G 787
Warring, C. B 122, 352

PAGE
Weather, Extremes of, in the Past..... 711
Wealth, The Distribution of..... 721
Welch, J. C..... 835
Wells, David A..... 11, 153, 289, 444
Wells, James S. C., Ph. D..... 393
Whelpley, H. M..... 842
Wilson, Dr. Andrew..... 666
Wind-Carving in Maine..... 860
Woods, and their Destructive Fungi..... 423, 604
" " " " " Note on..... 555

Yeo, Dr. J. Burney..... 63

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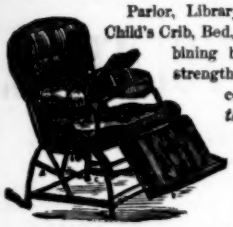

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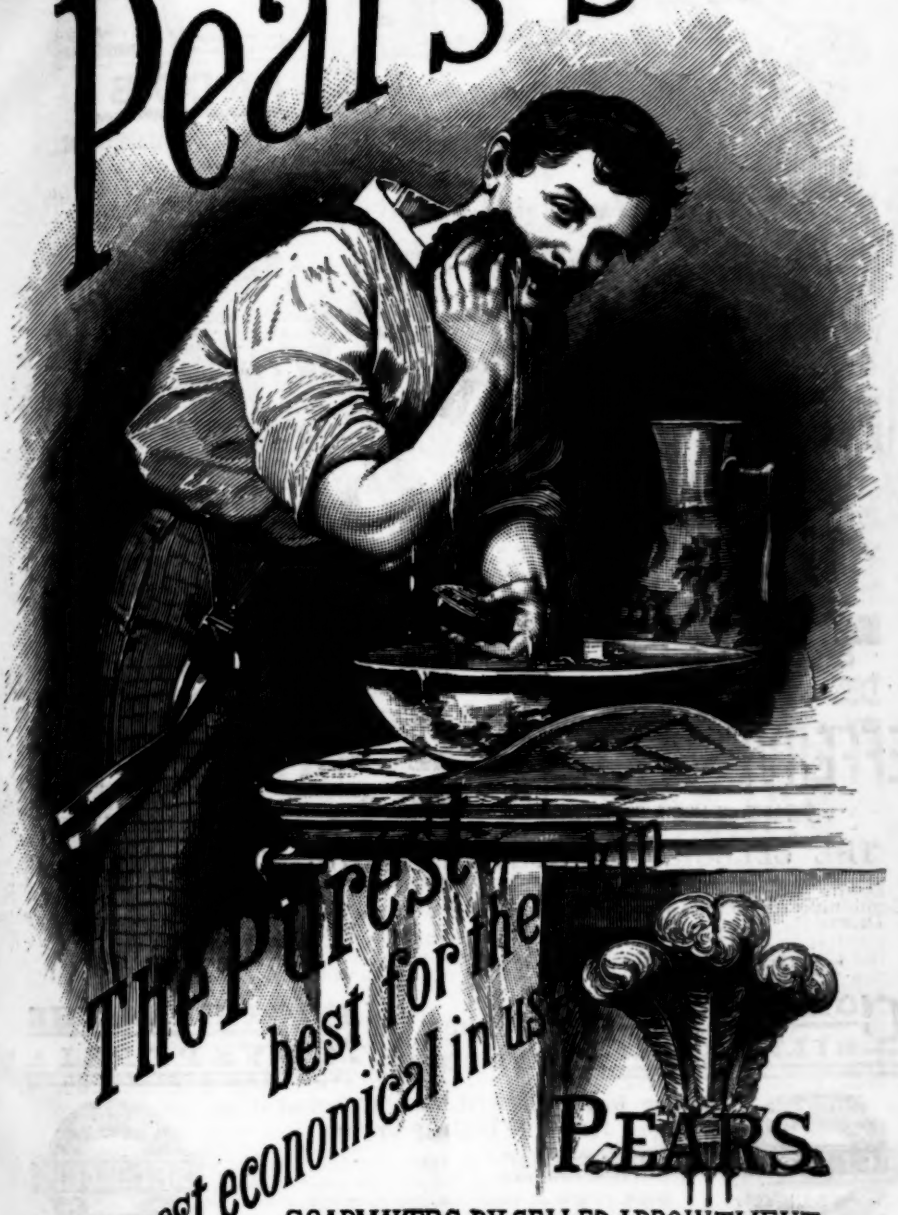

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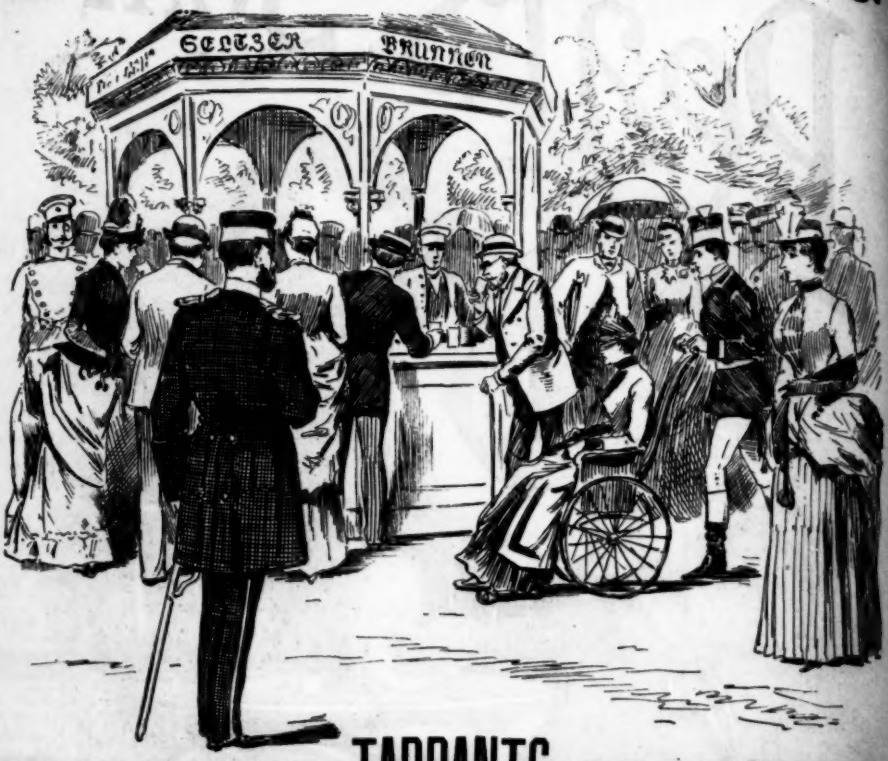

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CONTENTS.

		PAGE
I.	The Distribution of Wealth. By Charles S. Ashley	721
II.	Meteorites, Meteors, and Shooting-Stars. By Professor H. A. Newton, LL. D.	733
III.	Some Outlines from the History of Education. II. By Professor W. R. Benedict	747
IV.	The Microbes of Animal Diseases. By E. L. Trouessart. (Illus.)	761
V.	A Psychological Study of Fear. By Charles Richet	771
VI.	Some Peculiar Habits of the Cray-fish. By C. F. Holder	784
VII.	Le Play's Studies in Social Phenomena. By A. G. Warner	787
VIII.	Universal Time. By W. H. M. Christie, F. R. S.	795
IX.	A Bald and Toothless Future. By Virgil G. Eaton	803
X.	Life on a Coral Island. By Professor W. K. Brooks	806
XI.	Are Black and White Colors? By Harry Austin Doty	814
XII.	The Philosophy of Diet. By a Layman	818
XIII.	German Paleontological Museums. By Albert Gaudry	827
XIV.	Nitrification. By Professor H. P. Armsby	831
XV.	Sketch of General John Newton. (With Portrait.)	834
XVI.	Correspondence	841
XVII.	Editor's Table: Fraud and its Victims.—The Buffalo Meeting of the American Association	842
XVIII.	Literary Notices	845
XIX.	Popular Miscellany	856
XX.	Notes	863

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"Rheumatism is one of the most obstinate, as well as one of the most painful, of all diseases. While many other diseases yield to ordinary remedies, rheumatism defies them, or else seems for a while to be cured, only to appear again in some other form, or to torment some other part of the body than that in which it had first been started.

"One of our New York correspondents, having heard that Mr. Yates had been severely troubled with rheumatism, and had recovered from it, visited him, and had from his own lips an account of how it was.

"Said Mr. Yates: 'The trouble came on, not from exposure, as rheumatism often comes, but in a singular way attacking my feet. As I had for a long time been on my feet most of the day, and walking very actively, the soles became sore, and I sought relief from a distinguished surgeon. He gave me a preparation which I applied with wet cloths. I kept these cloths on my feet all night (not by his advice, however), for a number of nights. I felt great pain in my legs, principally in my knees. This was an unpleasant novelty to me, for I had not been laid up by sickness for a long time before that—probably a dozen years. Not only was I in such pain that it was with difficulty that I could walk, but I was almost helpless. Sometimes I was two hours in getting my clothes on. I could attend to business only by taking a carriage; but for my special business this afforded but little practical aid. Walking was almost an impossibility. I was soon greatly reduced in flesh, for the severe pain took away my appetite. The pain went up through my legs and body, and even stiffened the cords of my neck, giving me the appearance of a continual stiff neck. The cords of my right leg were drawn up so that the leg was shortened about two inches, thus causing a continual limp. In the knee-joints the pain was so intense that I had to keep swinging my legs as much of the time as I could, for when the joints remained still for a while they felt as if cemented, for the lack of lubricating material. The calves of my legs became considerably shrunken. Under one knee was a lump or bunch half as large as my fist, and as hard as a cobble-stone.

"'I went to a noted physician to consult him about my general condition, and especially about this lump, for the indications were that unless something were done for it I should be permanently lame. The physician said he saw no other way than to cut it out. I did not relish this advice.

"'Then I went to one of our principal hospitals, where I was told by the doctors that the better way would be to burn the lump away. I believe either of these methods would have made me a cripple for life. Think of the muscles and the nerves these men would have destroyed in such operations! I am using those nerves and muscles now.'

"'So you gave up the idea of surgery, did you, Mr. Yates, and adopted some less painful and more reasonable remedy?'

"'Yes. One day, about a year ago, I happened to make a business call on Dr. John Turner, of the Compound Oxygen Branch Office, 148 Fifth Avenue, New York. I had heard of Compound Oxygen, but had not supposed that it would be of any great advantage to me. But here I heard several gentlemen talking of what it had done for them and their friends. Dr. Turner said he thought there was a chance that it would do me good. He sent me a Home Treatment of it. I tried it, and let me tell you in connection with it I tried a pretty thorough change of diet. I lived very simply, throwing overboard pies, pudding, tea, tobacco, and even meat. For some time I lived on rye bread. I took the Oxygen for about three months.'

"'And with good effect, if I may judge from your present appearance.'

"'Yes, with very good effect. That and the diet brought me up nicely. In a week or two I began to be better. I took at this time no other medicine but the Oxygen. My first gain was in the reduction of the swelling and the departing of the pain. My appetite gradually came back, and I could enjoy moderate eating. The swelling went entirely away without the aid of the knife, or other appliances of the surgeons. I gained flesh and strength, and was again able to attend to business as before. I am still improving. I often have to ascend as many as one hundred flights of stairs in the course of a day, and I am now equal to the task.'

"Such thorough recovery as this from such a troublesome and obstinate disease as rheumatism is of interest to every rheumatic sufferer. Rheumatism is a disease which some have trifled with and others have given up to, in despair, as incurable. Indeed, there are eminent physicians who have admitted that they can not cure this malady. But it is important to every one that suffers from rheumatism, or who has friends among its victims, to know that Compound Oxygen has cured many cases of it, is curing others every day, and can be relied on for many more cures. Unlike many of the drugs which are given in the attempt to cure rheumatism, Compound Oxygen does not disorder the system, is not unpleasant to take, and leaves no evil effects behind it."

From a lady of Worcester, Mass., dated November 15, 1885, came this statement of case:

"Age 62; for ten years have been a sufferer. When nearly 52 took *whooping-cough* the second time, and have coughed every winter since. Had *pneumonia* six years ago; until then I suffered terribly with *nervous prostration* and *nervous dyspepsia*. When taken with pneumonia my nervousness all suddenly left me. After the pneumonia I could not bear my weight for a year and a half, and it was three and a half years before I could get on my crutches. The ligaments of joints stretched and troubled me that way. The forefinger of my left hand had to be set five times within one year, and that left the joints stiff. The left hip has troubled me by slipping, as I could not move it. *Rheumatism* moves from place to place. Have coughed mornings ever since I had pneumonia till I took influenza, the first of October."

The following gratifying report of results from use of one Home Treatment is dated April 4, 1886:

"Have a little Compound Oxygen yet. I expect my *cough* will entirely disappear as warm weather comes; if it don't, I shall have to have some more. I never used anything like it. *My rheumatism is better, so I can walk for the last six weeks without crutches or cane.* I am much better and growing so daily. It is slow, to be sure, but I am surely gaining. A lady who saw me last July for the first time, said she did not think then I could live until cold weather; but now she says I look as well as anybody, only if I was not so lame. I get up with the rest at six, eat breakfast at half-past six, sew or knit through the day, and look after my girl in the kitchen. We have six in our family; I do the buying and keep the family account-book; go to bed at nine o'clock and sleep nicely most every night. Is not that doing well? I think that if it had not been for the Compound Oxygen I should not have been alive now, for I was running down fast when I began to take it."

Compound Oxygen, its mode of action and results, a treatise of nearly two hundred pages, giving full and interesting information, is mailed free to every applicant by Drs. Starkey & Palen, 1529 Arch Street, Philadelphia, Pa.

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Vanilla Chocolate,

Like all our chocolates, is prepared with the greatest care, and consists of a superior quality of cocoa and sugar, flavored with pure vanilla bean. Served as a drink, or eaten dry as confectionery, it is a delicious article, and is highly recommended by tourists.

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Warranted ***absolutely pure Cocoa,*** from which the excess of Oil has been removed. It has *three times the strength* of Cocoa mixed with Starch, Arrowroot or Sugar, and is therefore far more economical, *costing less than one cent a cup.* It is delicious, nourishing, strengthening, easily digested, and admirably adapted for invalids as well as for persons in health.

Sold by Grocers everywhere.

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SUMMARY OF

Forty-first Annual Report

OF THE

New York Life Ins. COMPANY.

BUSINESS OF 1885.

Received in Premiums	$12,722,103.03
Received in Interest, Rents, etc.	3,399,069.71
Total Income	**$16,121,172.74**
Paid Death-claims	$2,999,109.64
Paid Endowments	741,764.47
Paid Annuities, Dividends, and for Policies Purchased	3,940,999.64
Total Paid Policy-holders	**$7,681,873.75**
New Policies Issued	18,566
New Insurance Written	$68,521,452.00

CONDITION JANUARY 1, 1886.

Cash Assets	**$66,864,331.81**
* Divisible Surplus, Co.'s Standard	$7,064,473.13
† Tontine Surplus, Co.'s Standard	3,123,742.77
Total Surplus, Co.'s Standard	**$10,188,215.90**
Surplus by State Standard	**$13,215,046.94**
Policies in Force	86,418
Insurance in Force	$259,674,500.00

* Exclusive of the amount specially reserved as a contingent liability to Tontine Dividend Fund.
†Over and above a 4 per cent. reserve on existing policies of that class.

PROGRESS IN 1885.

Excess of Interest over Death-losses	$399,960.07
Increase in Income	1,880,697.35
Increase in Surplus, State Standard	3,313,707.48
Increase in Assets	7,580,567.75
Increase in Insurance Written	7,036,902.00
Increase in Insurance in Force	30,291,914.00

Death-claims Paid.		Income from Interest.		Insurance in Force.		Cash Assets.	
1881	$2,013,206	1881	$2,433,654	Jan. 1, 1882	$151,760,824	Jan. 1, 1882	$47,238,781
1883	1,955,292	1882	2,798,018	Jan. 1, 1883	171,415,097	Jan. 1, 1883	50,800,396
1883	2,263,093	1883	2,712,863	Jan. 1, 1884	193,746,043	Jan. 1, 1884	55,542,992
1884	2,257,171	1884	2,971,624	Jan. 1, 1885	229,382,586	Jan. 1, 1885	59,283,763
1885	2,999,109	1885	3,399,069	Jan. 1, 1886	259,674,500	Jan. 1, 1886	66,864,331

DO NOT INSURE until you have seen full particulars of the Company's new style policies, which are specially valuable to those who outlive certain selected periods, while furnishing full protection to the families of those who die.

DO NOT FAIL to write the nearest Agent, or the Home Office, for such particulars—**at once.** The NEW YORK LIFE INSURANCE COMPANY, 346 & 348 Broadway, New York City.

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RUFUS W. WEEKS, Actuary.
THEODORE M. BANTA, Cashier.
D. O'DELL, Sup't of Agencies.

WILLIAM H. BEERS, President.
HENRY TUCK, Vice-President.
A. HUNTINGTON, M. D., Medical Director.

128